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SUMMARY REPORT: MODEL-PROTOTYPE COMPARISON STUDY OF DIKE SYSTEM--ETC(U)
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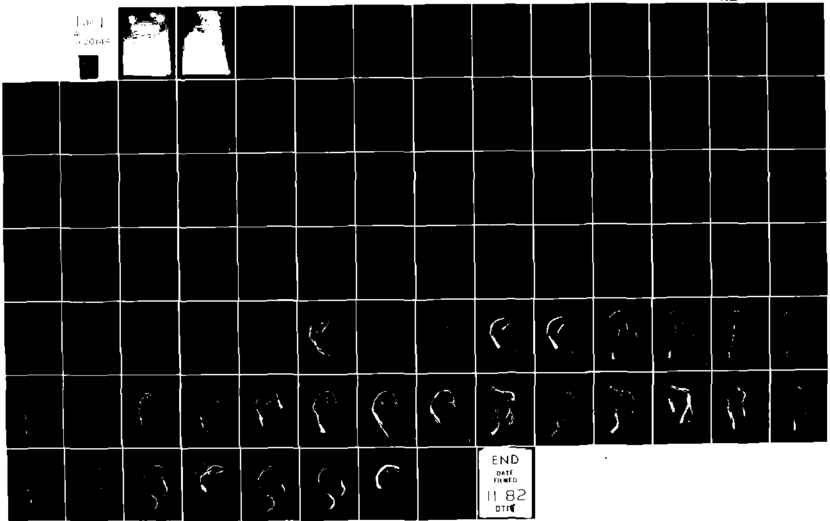

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In connection with the MRC Potamology Program, Movable-bed model studies were conducted of seven of the most complex and troublesome reaches of the Mississippi River to obtain some quick general indications of the effectiveness of plans proposed for the improvement and stabilization of those reaches. Because of the limited time available, the studies were conducted in an existing facility with little or no adjustment of the models and in some cases without a base test. Because of the limited size and shape of the facility,

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20. Abstract (Concluded)

only a relatively short reach of the river including the problem could be reproduced in each model with little or no overbank areas. The horizontal scale varied with each reach depending on its size and shape and were much smaller with a higher distortion of the linear scales than was considered desirable for studies of this type.

An analysis of the model results compared with developments in the river based on an evaluation of considerable prototype data indicated that the types of models used predicted, at least qualitatively, most of the principal trends that actually occurred in the river with the plans tested. The degree of accuracy of the models varied and depended to a considerable extent on the model adjustment, characteristics of the reach, flow conditions, and similarity between plan tested and actual construction.

The analysis of model and prototype data permitted an evaluation of the performance of various types of dikes and dike systems and some of the principles involved in the developments within alluvial streams.

PREFACE

This paper summarizes the results of model studies conducted to obtain some general indications of the effectiveness of dike systems proposed for the improvement in critical reaches of the Mississippi River, developments in the river in those reaches, and comparison of model indications with actual river developments covered in detail in Technical Report HL-82-10. The study was authorized by the President, Mississippi River Commission (MRC), in an indorsement dated 10 June 1975 to a letter from the U. S. Army Engineer Waterways Experiment Station (WES), subject: Model-Prototype Comparison, Study of Dike Systems, Mississippi River.

The analysis and evaluation of model and prototype data and preparation of this report were accomplished under the supervision of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory, by Mr. John J. Franco (retired), former Chief of the Waterways Division, WES, and former member of the MRC Potamology Board and Chief of Engineers, CE, Committee on Channel Stabilization, under a special contract as consultant for WES. The work was accomplished under the general supervision of Messrs. J. E. Glover, Chief of the Waterways Division, and L. J. Shows, Chief of the Navigation Branch, who also assisted in the preparation of data. Draft copies of reports on each separate reach were submitted to the Division Engineer, Lower Mississippi Valley Division, and to the District Engineers of the U. S. Army Engineer Districts, New Orleans, Vicksburg, Memphis, and St. Louis, for their review and comments.

Commanders and Directors of WES during the conduct of this study and the preparation and publication of this report were COL G. H. Hilt, CE, COL John L. Cannon, CE, COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
feet per second	0.3048	metres per second
miles (U. S. statute)	1.609344	kilometres

SUMMARY REPORT: MODEL-PROTOTYPE COMPARISON STUDY OF DIKE SYSTEMS, MISSISSIPPI RIVER

Potamology Investigations

PART I: INTRODUCTION

1. The Mississippi River Commission (MRC) Potamology Research Program included laboratory studies and field investigations to determine the characteristics of Mississippi River channels and factors affecting the performance of various types of training and channel stabilization structures. One phase of this program included a series of model studies of troublesome reaches of the lower Mississippi River to obtain some general indications as to the effectiveness of dike systems and plans proposed for the improvement of those reaches.

2. It was realized at the time the studies were undertaken that the conventional type of movable-bed model study could not be made because of the limited size of the flume and limited time available for model adjustment and testing. The scales of the models and lengths of reaches that could be reproduced were controlled by the size and shape of the available flume and the need for development of the hydraulic forces required to move the model bed material (fine sand) in simulation of the movement of sediment in the river reach under study. For this reason the model scales varied and were smaller with higher distortions than considered desirable for studies of this type. In spite of the limitations, it was believed that some general indications could be provided as to the performance of the proposed plans and of any modifications that might be required.

3. The reaches studied in the models were also study reaches in the river and were therefore observed closely in the field. Field data taken in these reaches included periodic surveys of the riverbed covering periods before, during, and after construction. This provided a unique opportunity to determine the value of these types of studies and some indication of the degree of accuracy possible, from a comparison

of the model indications with developments in the field. This comparison involved an analysis of model results and procedure used and an analysis and evaluation of all the prototype data made available at that time. This report is a summary of Technical Report HL-82- , "Model-Prototype Comparison Study of Dike Systems, Mississippi River; Potamology Investigations," by John J. Franco, dated January 1982, and presents some of the more significant results of the analyses and the principal conclusions developed.

PART II: MODEL STUDIES

Description of Models

4. The models used in these studies were of the movable-bed type, each reproducing a reach of the Mississippi River sufficient to include the problem area with little or no overbank areas. The bed and banks of the model channels were molded in fine sand having a mean grain diameter of 0.2 mm. In most cases, the banks were protected with crushed rock or sand-cement mortar to prevent sloughing or to reproduce banks protected by revetment in the river. Because of the differences in the geometry and the nature of problems being studied, the horizontal scales varied with each study and were generally smaller than those considered desirable for studies of this type, resulting in a high distortion of the linear scales (see tabulation below).

Reach	Channel Reproduced, River Miles	Linear Scales Horizontal	Linear Scales Vertical	Distortion	Verification Test	Base Test
Choctaw Bar	558.0-568.0	1:650	1:60	10.8	No	Yes*
Island 21-Wrights Point	814.5-824.5	1:360	1:60	6.0	Limited	No
Caruthersville-Linwood Bend	838.5-850.5	1:540	1:60	9.0	No	Yes*
Baleshed-Ajax Bar	478.6-496.4	1:600	1:60	10.0	Limited	No
Cracraft-Sarah Island	500.5-514.5	1:480	1:60	8.0	Limited	No
Keyes Point-Forked Deer	785.0-801.0	1:600	1:60	10.0	No	Yes*
Island No. 63	632.0-645.0	1:400	1:60	6.7	Yes	Yes

* Some minor adjustments made during initial operation.

Adjustment and Verification

5. The reliability and accuracy with which movable-bed models reproduce prototype conditions are usually based on the model verification. The normal verification is the process of adjusting the model hydraulic forces, time scale, rate of introducing bed material, and operating technique until the model has demonstrated its ability to reproduce conditions known to have occurred in the prototype during a given period with a reasonable degree of accuracy. The amount of adjustments made on the models used in these studies varied; in some models the adjustment and verification were omitted entirely because of limited time available and in others the model was adjusted only until the general trends indicated by the prototype data were reproduced. The time scale used to reproduce the stage-discharge hydrograph was selected arbitrarily since sufficient prototype data were seldom available that could be used to indicate rate of changes.

Base Test

6. After adjustment and verification of a movable-bed model and before tests of improvement plans are undertaken, a base test is usually conducted. This procedure was followed in only some of these studies. Base tests were started with the bed of the model molded to the latest available prototype survey and operated by reproducing an annual average hydrograph that could be considered as typical for the reach and used for the tests of the improvement plans. The purposes of the base test are to determine the conditions that would develop with the selected hydrograph and to provide a basis of comparison in determining the effectiveness of the proposed plans tested. The hydrograph is usually repeated until the channel becomes reasonably stable or when changes develop that would not be permitted to occur in the prototype before construction is undertaken.

Tests of Improvement Plans

7. Tests of improvement plans were undertaken with the bed of the model either as that obtained at the end of the base test or with the bed of the model remolded to the conditions indicated by the latest available prototype survey. Before start of the tests, the proposed plan was installed as it would be when construction of the plan in the river is completed. In some cases, the plan was installed in steps based on the proposed construction schedule. In most cases, the test of each succeding plan was started with the bed of the model as that obtained at the end of the test of the preceding plan, depending on changes that had occurred and whether or not the new plan was an addition or modification of that plan. No maintenance dredging was performed in any of the tests of plans. Tests of plans and modifications were conducted in close coordination with representatives of the District concerned and the MRC.

PART III: PRINCIPLES AND TERMS USED

Lateral Differential in Water Level

8. Observation of developments in movable-bed models, evaluation of prototype data, and studies on the performance of dikes at the U. S. Army Engineer Waterways Experiment Station (WES) have indicated that the movement of sediment and developments within the channel of an alluvial stream have to be considered in three dimensions. The third dimension is provided by the Franco principle of lateral differential in water level stated as follows: "When conditions are such that a lateral differential in water level (or transverse slope) exists or is produced by changes, there will be a tendency for at least some of the total flow to move toward the lower elevation; the slower moving, sediment-laden bottom currents can make the change in direction easier than the faster moving surface currents and account for the greater concentration of sediment moving toward the lower elevation." This general principle is involved in many of the developments in alluvial streams including the development of sandbars on convex side of bends; movement of sediment around the end and behind dikes or other obstructions; development of cutoffs and side channels; shoaling downstream of a tributary stream, in harbor entrances, lock approaches, etc. In each case there is either a buildup in water level on one side or a reduction caused by channel enlargement, channel contraction, and/or flow diversion that causes some of the flow to change directions laterally.

9. Lateral differential in water level might be local or extend across the channel as in bends. Eddies are formed in areas where the water level is lower than in the adjacent channel. Lateral differential in water level is difficult to measure in the field but can be anticipated from a study of physical conditions and their effects on flow and the alignment of the principal currents. For maximum effectiveness, structures and changes should be designed to provide a favorable lateral differential in water level based on the effects desired.

10. Evaluation of model and prototype developments and

discussions with regard to the effectiveness of proposed plans are based to a large extent on the principle of lateral differential in water level.

Dike Structures

11. The structures used in channel improvement and development consisted mostly of rock dikes and revetment. Rock dikes vary as to type and arrangement, depending on the problem and purpose of the plan. Revetment consisted of fixing the bank or banks along a given alignment without regard to the type that might be used in the river. The various types of dikes and terms used are given below.

a. Spur dikes - The most common type of dikes used in channel improvement is referred to herein as "spur dike" and extends from a riverbank channelward in a direction more or less normal to the channel being developed. These dikes have also been referred to as transverse dikes, cross dikes, wing dams, jetties, groins, etc. These dikes are usually included in a dike system consisting of two or more dikes and may be normal to the channel, angled toward the upstream, or angled toward the downstream. The crest of individual dikes might be level or sloping from the bank toward the channel and the crest of each succeeding dike in a system might be at the same, a higher, or a lower elevation than the one upstream based on the low-water plane.

   (1) L-head dikes - L-head dikes are spur dikes with a section extending downstream from the channel ends, generally parallel to the channel line. The L-head section can be used when the spacing between dikes is too great, to reduce scour on the end of a spur dike, or to extend the spur dike system farther downstream.

   (2) Level dike system - The crest elevation of each dike in the system is the same.

   (3) Stepped-up dike system - The crest elevation of each succeeding dike is higher than that of the dike upstream.

   (4) Stepped-down dike system - The crest of each dike is lower than the dike just upstream.

b. Vane dikes - Vane dikes consist of separate lengths of

dikes located out from the bank in the form of vanes with space in between dikes. These dikes are placed at a small angle to the currents to develop the desired lateral differential in water level.

Channel Dimensions

12. Some of the terms used in describing channel conditions and factors affecting channel development are outlined below.

- a. Depths. Depths are in feet below the low-water plane. Project depth in the reaches covered herein is generally 9 ft.* However, in most cases depths of 10 ft were considered adequate for navigation in the analysis of data.
- b. Elevations. Elevations are in feet above the low-water plane. Elevation of the low-water plane and zero of gages are in feet referred to National Geodetic Vertical Datum (NGVD).
- c. Low-water plane. The low-water plane is a sloping reference based on average low-water conditions. The low-water plane may be referred to as mean low water (mlw), average low-water plane (ALWP), or low-water reference plane (LWRP).
- d. River miles. Unless otherwise specified, mileages are river miles above Head of Passes.
- e. River stages. River stages are in feet above the low-water plane. In some cases, stages are referred to the reading on a specific gage and are so stated.
- f. Water-surface slopes. Water-surface slopes are expressed in feet per mile based on actual scaled distance between measuring points rather than established river miles.

Model Tests

13. Each test consisted of the operation of the model to determine the effectiveness of a proposed plan or modification of plan and might consist of one or more "runs." Each run consisted of one reproduction of the average annual hydrograph selected for the study of the reach. Surveys of the model bed are usually made at the end of each run.

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 4.

PART IV: CHOCTAW BAR REACH

Description of the Prototype

14. The Choctaw Bar reach of the Mississippi River at the time of the model study was essentially a large bend of more than 90 deg with the main channel along the left side of a large island known as Choctaw Bar (Plate 1). The main channel in that reach extended from along the Cypress Bend revetment on the right bank at about mile 567, crossed toward the left bank just downstream, and followed that bank around the bend. The left bank from below the crossing to the bend was relatively straight for about 3 miles except for a landward bulge opposite the head of Choctaw Bar. Along the right bank below the crossing toward the left bank, there was a narrow channel with depths slightly below ALWP and a high sandbar to the left between that channel and the main channel. Between the sandbar and Choctaw Bar, there was a secondary channel as much as 2000 ft wide with depths of as much as 8 to 10 ft through most of its length. Flow through this channel moved toward and along the Pair-O-Dice revetment on the right bank and then crossed toward the left bank below the end of Choctaw Bar rejoining flow through the main channel.

The Model Study

Description of model

15. The model for the study of the Choctaw Bar reach reproduced the Mississippi River channel between miles 568 and 558 to a horizontal scale of 1:650 and vertical scale of 1:60, model to prototype. The channel bed and banks were molded to the configurations indicated by the survey of February-March 1967 (Plate 1), and no attempt was made to reproduce any overbank areas or to simulate the effects of vegetation or the erodibility of gravel bars or sandbars within the banks. Since this was to be a quick study, very little adjustment was made to the model and the usual verification had to be omitted. The model was

operated for the base test and test of the improvement plan by reproducing the hydrograph shown in Plate 2 which was based on average flow conditions in the lower Mississippi River.

<u>Base test</u>

16. Results of the base test indicated some changes from the conditions indicated by the February-March 1967 survey. The crossing toward the left bank had shoaled and there was some erosion of the sandbar along the right bank just downstream of the crossing. Less depth was maintained in the channel along the left bank downstream of the crossing, and the head of Choctaw Bar tended to erode. When it was determined that the head of the bar in the river consisted of gravel, it was armored in the model. There was also some shoaling of the side channel along the right side of Choctaw Bar caused by erosion of the head and left side of the sandbar upstream. In general, results of this test indicated that the model was not in complete adjustment but was adequate to indicate general trends within the reach.

<u>Improvement plan</u>

17. The plan for the improvement of the reach as initially proposed and tested in the model was designed to produce a closure of the side channel by diverting sediment into the channel. This plan consisted of three spur dikes extending from the right bank downstream of the crossing toward the left bank and three vane dikes extending from the river end of the lower spur dike across the side channel. The spur dikes had sloping crests with a stepped-down effect. The bank ends of the dikes were at el 21, 19, and 17 and the river ends at el 16, 14, and 12, respectively, from upstream to downstream. The vane dikes were each 1200 ft long at el 10 for the upper dike which extended from the river end of the lower spur dike (forming essentially an L-head) and at el 8 for the other two dikes.

<u>Model results</u>

18. Results of the model study indicated that the plan as tested would produce a closure of the side channel by deposition of sediment diverted into the channel (Plate 3). The model study also indicated that the rate of sediment diversion and deposition would depend on the

rate of the erosion of the head of Choctaw Bar. When the head of Choctaw Bar receded beyond the alignment of the vane dikes, the rate of deposition increased rapidly.

Prototype

Construction

19. The plan as constructed in the river was essentially as tested in the model.

River developments

20. Deposition within the side channel in the river started soon after the completion of the structures. However, the rate of deposition initially was slower than that indicated by the model results but increased rapidly when the head of Choctaw Bar receded beyond the alignment of the vane dikes. There had been a local failure in the lower spur dike near the bank end before the 1973 highwater. After the 1973 highwater, deposition had formed a partial closure of the side channel to elevations above 20 ft extending from Choctaw Bar to the river portion of the spur dike farthest downstream (Plate 4). There had been considerable deposition in the channel along the right bank except just downstream of the lower spur dike which could have been affected by failure in the dike on that side. However, during the same period, the navigation channel at the downstream end of Choctaw Bar (downstream of the model limits) filled above 10 ft, and extensive dredging was required. During the high water of 1974, maintenance dredging continued to be a problem around the bendway channel; and some enlargement of the old secondary channel was observed. To ensure a continued deterioration of the chute during all flow conditions and force more flow around the bendway, to improve navigation conditions at the downstream end, it was concluded that a positive closure of the chute should be constructed.

21. During 1974, the spur dike farthest downstream (dike 3) was raised to el 22 at its bank end and to el 20 at its river end except that a 350-ft gap at ALWP was left near the center of the dike. A scour hole with a depth of more than 60 ft existed just downstream of

the gap left in the dike. The vane dikes had been raised to el 20 with the gap between vane dikes 3B and 3C closed to the same elevation and an extension placed from the lower end of vane dike 3C to the head of Choctaw Bar sloping upward to el 38 on the bar. The gap between vane dike 3A (L-head) and 3B was to an elevation varying between ALWP and -20. These modifications were not tested in the model. During October 1974, a 300-ft gap with a bottom elevation estimated at 30 ft below the ALWP was found in spur dike 3 about 1500 ft from its bank end, and a 600-ft gap with bottom elevation at about 17 ft, some 1200 ft from its river end. By April 1975, scour had occurred along the downstream side of vane dike 3A and the closure between that dike and vane dike 3B, reaching a maximum depth of 36 ft (Plate 5). There was also scour and deepening of the channel downstream of the dikes along the Pair-O-Dice revetment on the right bank.

Discussion and Conclusions

22. In spite of the limitations of the model study, developments in the river generally provided confirmation of the results obtained from the study. Comparison of model and prototype indicated the value of these types of studies in the development of plans for the solution of problems in complex reaches of the river, and in the development of new principles for the design of better and more effective structures. The raising of dike 3 and the continuous structure across the side channel constructed in the river in 1974 were not tested in the model. The continuous structure did, however, significantly reduce the amount of dredging required at the lower end of the reach prior to its construction. Results of the model study and developments in the river indicated the effectiveness of structures for the closure of side channels by diverting sediment into the channel.

PART V: BALESHED-AJAX BAR REACH

Description of the Prototype

23. The Baleshed-Ajax Bar reach of the Mississippi River extends from the Mayersville revetment (mile 495.5) to Ajax Bar (mile 482.0). At the time of the April 1967 survey, the channel from along the Mayersville revetment crossed toward the right bank a short distance downstream and followed that bank and the Baleshed-Stack Island revetment in a relatively straight line to about mile 485.5, then crossed toward the left side just below the end of the Ben Lomond revetment (Plate 6). At that time there were five dikes along the left bank extending downstream starting at the end of the Mayersville revetment (referred to as the Baleshed Landing dikes). Just downstream of the dikes, a channel existed on both sides of a high center bar or island with the main channel being along the right side. Downstream at about mile 488 there was a side channel across the center bar extending toward the upper end of the Ben Lomond revetment. From the lower end of the revetment and along the right side of Ajax Bar, the channel was rather narrow and formed a crossing toward the Hagaman revetment at a rather sharp angle. The chute between Ajax Bar and the left bank had been partially closed with four dikes extending from the left bank to the bar.

24. Vane dikes 2A, 2B, and 2C were under construction during the latter part of 1967 and were completed in June 1968. The purpose of these dikes, constructed across the side channel mentioned above, was to reduce flow toward the left bank and, with erosion and dredging of the right bank downstream, to maintain an adequate channel along the realigned bank. Dredging of the right bank had been in progress at the time construction of the dikes was undertaken in an effort to eliminate the crossing toward the left bank before entering Hagaman Bend.

25. By the time of the October 1968 survey, Ben Lomond dike 1L was completed, dike 2L was nearly completed, and the Ajax Bar dikes were under construction. The channel along the right bank opposite and

downstream of the vane dikes had deepened and widened to some extent, but the minimum width of the channel below ALWP was still less than about 1000 ft (Plate 7). There was a sharp angle in the right bank toward the left at the time of the survey.

The Model Study

Description of model

26. The model used for this study reproduced the reach of the Mississippi River between miles 478.6 and 496.4 to a horizontal scale of 1:600 and vertical scale of 1:60. The model adjustment was limited to that required to reproduce only the general characteristics of the prototype as indicated by the 1967 and 1968 surveys. The model as adjusted indicated a greater tendency for the sandbars to erode and the channels to aggrade than the prototype, but was considered adequate for the purpose of the study. The sandbars and a portion of the right bank were molded in clean sand for the test of the improvement plans. The right bank was stabilized when it reached the proposed revetment line. Test of the first improvement plan was undertaken with the model channel bed as obtained at the end of the final adjustment. Each succeeding test was started with the bed of the model the same as that obtained at the end of the preceding test except for the final plan which was started with the condition obtained at the end of the second test.

Improvement plans tested

27. The first plan tested (plan A) included the existing Ben Lomond dikes and the Ajax Bar dikes completed in October-November 1968. Plans B, C, and D included 6, 9, and 12 vane dikes downstream of the end of the lower Ben Lomond spur dike. The vane dikes were each 1000 ft long with tops at el 15. The dikes of plan B were spaced 750 ft apart, and those of plans C and D were spaced 1000 ft apart. Plans E and F included the addition of two and three spur dikes below the existing Ben Lomond dikes, respectively. Plan G was the same as plan F with the extension of the Ajax Bar dikes (Plate 8). Plan H was the same as plan B (six vane dikes) with the extension of the Ajax Bar dikes.

Results of model tests

28. Results of the model tests indicated that a reasonably satisfactory channel could be developed along the proposed alignment with vane or spur dikes. To obtain a satisfactory channel, particularly in the lower reach, the structures would have to be extended far enough downstream to prevent excessive dispersion of the low and medium flows approaching the bend. The vane dikes of plan D produced a reasonably good channel as well as the spur dikes of plan G (Plate 8) with the flow conditions reproduced in the model. Results with the spur dikes were better than with the vane dikes. There was a tendency for the low-water channel in the long straight reach to meander within the control limit lines. Some scouring occurred on the ends of some of the vane dikes during the low flows because of the flow moving toward the dikes. In the upper reach, there was a tendency for some scouring of the sandbar along the ends of the Baleshed Landing dikes which had some effect on the crossing from the Mayersville revetment toward the right bank.

Prototype

Construction

29. During 1970 vane dike 2C was extended 200 ft downstream and vane dikes 2D and 3A were constructed. Ben Lomond dike 3L was completed in 1971 and vane dikes 3B and 3C were completed in 1974 (Plate 9). The above is all of the construction performed in the reach up to May 1975 except for dredging along the right bank opposite the dikes and downstream extension of the Baleshed-Stack Island revetment.

River developments

30. During the period 1969-1975, there had been some increase in the attack on the Mayersville revetment with some erosion of the sandbar along the river ends of the Baleshed dikes and scouring to a depth of 70 ft near the bank end of dike 5. The crossing from the Mayersville revetment was rather unstable, changing in depth and alignment with river stages. The channel along the right bank downstream of the crossing had

extended farther downstream with dredging and erosion of the bank but tended to meander within the control limits.

31. During the development period some deep scour holes developed off the ends and downstream of some of the vane dikes during low flows and filled in during flows that overtopped the Ben Lomond spur dikes. Also because of the alignment of the right bank which angled toward the left there had been a strong attack on Ajax Bar dikes A2 and A3, developing scour holes of more than 100 ft deep but later disappeared with the extension of the Ben Lomond dike system. During low flows the drop in water-surface elevation from the right to left bank across the vane dikes was as much as 1.4 ft and decreased to about 0.3 to 0.4 ft during flows that substantially overtopped the spur dikes.

32. By the end of the study period (May 1975), the crossing toward the right bank from the Mayersville revetment was long and shallow and the channel along the right bank opposite the Ben Lomond dikes and approaching Hagaman Bend was wide but less than project depth (Plate 9).

Discussion and Conclusions

33. The model adjustment was limited and indicated some differences in developments from those indicated by the prototype surveys. Some of these differences could be attributed to the differences in the erodibility of the right bank downstream of the Baleshed-Stack Island revetment and sandbars, some of which contained gravel and/or vegetation. In the test of plans, the model bed was generally the same as that obtained at the end of the preceding test and would not be the same as the prototype at time of construction of each phase of the proposed plan. However, the model did indicate the principal changes and developments that could be expected with the hydrograph reproduced and the relative effectiveness of the plans tested.

34. The model and developments in the river indicated that the channel over the crossing from the Mayersville revetment toward the right bank would tend to be unstable and vary with changes in flow

conditions with a tendency for the sandbar along the river ends of the Baleshed dikes to erode. Also, the model and prototype indicated the tendency for the low-water channel in the long straight reach along the right bank to meander within the control limit lines.

35. The model indicated that because of the dispersion of the high flows some difficulties could be encountered in maintaining a satisfactory channel along the right bank approaching Hagaman Bend during some flows without the extension of the Ben Lomond dike system farther downstream or extension of the Ajax Bar dikes. By May 1975, an adequate channel along the right bank had not been developed in the lower reach without this extension.

PART VI: CARUTHERSVILLE-LINWOOD BEND REACH

Description of the Prototype

36. The reach of the Mississippi River referred to as the Caruthersville-Linwood Bend reach extends from about mile 850.5 to about mile 838.0. The reach includes two alternate bends with about a 7-mile straight reach in between forming an "S" shaped alignment. In 1967, the low-water channel crossed from the right bank below Little Prairie Bend toward the left bank (Blaker Towhead) and followed that bank for a short distance before crossing toward the right bank on the convex side of Linwood Bend (Plate 10). The channel over this crossing and the crossing toward the left bank (across the convex side of the bend) was of less than adequate depth and was maintained by dredging. The concave bank in Linwood Bend had been revetted between miles 837.7 and 841.2 during 1932-1953. However, at the time of the 1967 survey, the channel along the revetment upstream of mile 839.8 was narrow and shallow, masked by sandbars and islands with top elevations up to more than 30 ft, and partially covered with vegetation.

37. Three spur dikes had been constructed along the right bank to improve and stabilize the crossing from the right bank toward Blaker Towhead. There was some caving of the riverside of the towhead which formed the left bank of the low-water channel. Improvement plans proposed for the reach included the construction of five more dikes along the right bank downstream of the existing dikes and extending into the bend, two dikes along the left bank downstream of Blaker Towhead, and grading and revetting of the riverside of the towhead.

The Model Study

Description of model

38. The model reproduced the reach between miles 850.5 and 838.3 to a horizontal scale of 1:540 and vertical scale of 1:60 (Plate 10). The usual procedure of adjusting and verifying the model was omitted.

Except for some minor adjustments based principally on observations and judgment during the beginning of the base test, no special efforts were made to obtain a reasonably good reproduction of the characteristics of the prototype reach.

Base test

39. The base test and tests of the improvement plan were conducted by reproducing a hydrograph that was considered typical of the average and generally similar to that shown in Plate 2. Results of this test indicated differences in some of the general trends compared with conditions indicated by the prototype survey of 1967. Some of the differences could have been caused by the differences in flow conditions reproduced and those that preceded the prototype survey; introduction of more bed material in the model than was required, causing the model channel to aggrade; and the degree of erodibility of Blaker Towhead and some of the sandbars that were not properly simulated in the model.

Tests of improvement plan

40. Tests of the proposed improvement plan were conducted in three steps based on the proposed construction schedule. The first test included right bank dikes 4 and 5 and revetting of the riverside of Blaker Towhead, the second test included dike 6, and the third test included dikes 7 and 8 and Tennemo dikes 1 and 2 on the left bank downstream of Blaker Towhead (Plate 11). No modifications of the originally proposed plan were tested.

41. Results of the first test indicated that dikes 4 and 5 would produce only local changes, particularly in the crossing from Blaker Towhead toward the right bank downstream. The addition of dike 6 reduced shoaling in the crossing from the left bank toward the end of the dike and improved depths and alignment of the channel from the end of the dike toward the left bank. With the completed plan, a channel of adequate depth and good alignment was developed along the left bank from the lower end of Blaker Towhead and around the bend along the Linwood Bend revetment (Plate 11). There was some increase in the tendency for the channel along Blaker Towhead to shoal which could be attributed partly to the natural tendency for the model channel to

aggrade and partly to the backwater effects of the additional dikes before the channel around the bend could be fully developed.

Prototype

Construction

42. After the model study was discontinued in February 1968, the following construction was performed in the river:

- a. Dikes 4 and 5 were constructed along the right bank by November 1968. Dike 5 was considerably shorter than was originally proposed and tested in the model.
- b. Dikes 8 and 9 were completed in November-December 1969. Dike 8 was not as long as that originally proposed and tested in the model; dike 9 was not part of the original plan and was not included in the model study.
- c. The riverside of Blaker Towhead was graded and revetted in 1969.
- d. Tennemo dikes 1 and 2 below Blaker Towhead were completed by July 1971.
- e. Some work on dike 5 and construction of dike 6 were accomplished in 1975. Dike 6 was shorter than that originally proposed and tested in the model.
- f. A 15-ft-deep channel was dredged along the left bank from the ends of Tennemo dikes toward the Linwood Bend revetment during September-October 1974 and redredged in 1975.

River developments

43. Crossing toward Blaker Towhead. The channel over the crossing toward Blaker Towhead generally had a good alignment and adequate depths up to the time of the 1973 high-water period when the channel shoaled to less than project depth. However, by the time of the May 1976 survey the crossing had moved upstream toward the upper end of Blaker Towhead with depths of more than 15 ft (Plate 12).

44. Channel along Blaker Towhead. The channel along Blaker Towhead had shoaled to depths of 7 to 8 ft during the 1973 high water but later increased in depth and extended farther downstream. There was some flanking of the revetment along the lower end of the towhead with the deepest part of the channel extending close and somewhat landward of the river end of Tennemo dike 1.

45. Crossing toward right (convex) bank. Construction of dikes 4 and 5 in 1968 and dikes 8 and 9 in 1969 had some effects on the alignment of the channel over the crossing from Blaker Towhead, but the channel continued to be troublesome and required considerable maintenance dredging. During the period 20 July-31 October 1974, more than 2 million cu yd was dredged over the crossing. Some of the dredge cuts shoaled to less than project depth within a few days after dredging was completed. Although a 15-ft-deep channel was dredged along the left bank toward Linwood Bend in 1974 and dike 6 along the right bank was completed in 1975, there was still a strong tendency for the low-water channel to cross from the end of Tennemo dike 1 on the left bank toward the end of dike 8 on the right bank. The channel over the crossing had shoaled to controlling depths of 5 ft by the end of 1975 but had adequate depth by the time of the May 1976 survey (Plate 12).

46. Channel along the left bank. During the 1973 high water, the channel along Blaker Towhead had extended farther downstream toward the bend before crossing toward the right bank, and there had been considerable erosion of the sandbars along the revetted bank in Linwood Bend. A 15-ft-deep channel was dredged along the left bank from the end of Tennemo dike 1 toward the revetted bank during September-October 1974 and was redredged in 1975. However, even with dike 6 on the right bank in place, the tendency for the channel to cross toward the right bank from the ends of the Tennemo dikes continued with some shoaling in the dredged channel toward the revetted bank. By May 1976, the dredged channel had shoaled considerably just upstream of the revetted bank, but depths along the concave bank had increased to more than 20 ft (Plate 12).

Discussion and Conclusions

47. The model indicated that all of the structures as originally proposed would be required to develop a satisfactory channel along the revetted bank in Linwood Bend with the flow conditions reproduced. There was considerable development of the channel along the Linwood

Bend revetted bank in the river and of erosion of the sandbars riverward. However, in the river, dike 7 had not been constructed and dikes 5 and 8 were shorter than those tested in the model. Also, the lower end of the revetment along Blaker Towhead was not permitted to flank in the model and no maintenance dredging was performed in the crossing toward the right bank. Developments indicated that a satisfactory channel could be developed along the left bank and the Linwood Bend revetment but would probably require some additional structures based on the plan as originally proposed and tested in the model.

48. Because of the differences in flow conditions and differences in the plan as tested and actual construction in the river, a direct comparison between model and prototype cannot be made. In spite of the limitation of the model adjustment and differences in conditions between model and prototype, the results of the model study did indicate at least qualitatively most of the principal effects that could be expected with the plan as tested.

PART VII: ISLAND 21-WRIGHTS POINT REACH

Description of the Prototype

49. The Island 21-Wrights Point reach is that portion of the Mississippi River between about miles 824 and 814 (Plate 13). The reach was the lower portion of an "S" curve with divided flow in each of the two bends. In the upper bend, flow was divided on either side of Island 21 which is about 5 miles long and located along the left bank on the convex side of the bend. Flow through the chute channel, between Island 21 and the left bank, was less than 10 percent during river stages of 5 ft or lower, about 30 percent during medium stages, and probably higher with higher river stages. A 3173-ft-long stone dike with crest at el 23 was constructed across the lower reach of the chute channel in November 1968. The closure dike was partially breached in January 1969 and restored to a 20-ft elevation in January 1970.

50. Between the upper and lower bends, there is a relatively straight reach more than 3 miles in length. Five spur dikes of timber pile construction were placed along the right bank downstream of the upper bend in 1961-1962 and later modified with stone fills in 1966 and again in 1968. The Obion River, a small stream, enters this reach from along the left bank about 5 miles downstream of Island 21. The characteristics of this stream and its effect on channel development could not be determined from the data available.

51. The lower bend makes a turn to the right of about 180 degrees with a large center bar referred to as Wrights Point Bar and a side channel between the bar and right bank. Flow in the side channel, which was wide and about half the length of the channel around the bend, had been increasing with time varying from less than 40 percent of the total flow to more than 50 percent during the period 1967-1969. The navigation channel approaching the bend from along the spur dikes and along the left bank around the bend had been unstable and of less than project width and depth based on the low-water plane.

52. After construction of the vane dikes across the entrance to

the side channel and modification of the spur dikes during the latter part of 1968, there was little change in conditions through the problem reach. The channel from along the spur dikes crossed toward the left bank with controlling depths of less than 10 ft in June 1969 and only about 5 ft by October 1969 (Plate 14). The sandbar along the left bank between miles 820.0 and 821.5 had increased in elevation to above 5 ft and extended closer to the left bank. Depths in the channel along the left bank in the bend had shoaled to less than 10 ft just downstream of the crossing. The head of Wrights Point Bar had receded about 2500 ft and flow through the side channel (between the bar and right bank) was about 54 to 55 percent of the total with river stages of about 10 to 15 ft. A channel had formed at the head of the bar and extended toward the right bank at a rather sharp angle, causing considerable scouring and caving of the bank.

The Model Study

Description of model

53. The model for the study of the reach reproduced the Mississippi River channel between miles 824.5 and 814.5 to a horizontal scale of 1:360 and vertical scale of 1:60, model to prototype. Adjustment of the model was rather difficult because of the variations in slopes through the reach, and incomplete information on the permeability of the pile dikes and amount of stone fill in the dikes. Tests of modifications in the improvement plan were undertaken with the model not in good adjustment but considered sufficient to provide some general indications as to the effectiveness of the proposed modifications. The adjustment test indicated that the model channel would tend to degrade compared with the prototype with a greater tendency for deposition in the side channel to the right of Wrights Point Bar. The study did not include a base test.

Tests of improvement plans

54. Plans tested were based on the existing prototype conditions except for the installation of two additional vane dikes across the side

channel in plans A and B, the installation of a dike extending from the head of Wrights Point Bar upstream (plans C and D), and plan C with a closure dike across the side channel (plan E).

Model results

55. Results with tests of plans A, B, and C indicated some increase in deposition in the side channel with some decrease in the amount of flow diverted through the channel. By the end of the test of plan C, there was a tendency for the channel downstream of Island 21 and the crossing toward the right bank dikes to move farther downstream. Plan D was the same as plan C except for the closure of the gap between the upper two vane dikes. Results with this plan were generally not as good as those with plan C.

56. Plan E with the closure dike across the side channel produced an adequate channel through the reach (Plate 15). There was a tendency for the channel downstream of Island 21 to remain along the left bank opposite the spur dikes, but this tendency was not fully developed with only one reproduction of the hydrograph. There was considerable scour downstream of the closure dike.

Prototype

Construction

57. Construction in the river included the construction of the dike extending upstream from the head of Wrights Point Bar (similar to model plan C) during 1970, dike 6 across the side channel in 1973, and a second dike (dike 7) across the side channel downstream of and 3 ft lower in elevation than dike 6.

River developments

58. With the dike extending upstream of the head of Wrights Point Bar in place, there was some deposition in the side channel but not as much as that indicated by the model results. The channel downstream of Island 21 tended to remain along the left bank and to eliminate the crossing toward the spur dikes. Based on this tendency considerable dredging was accomplished, mostly along the left bank,

involving the removal of more than 7 million cu yd of material during August 1971 to October 1973. Some of the dredge cuts filled in completely within a short time and others shoaled substantially, indicating that a stable channel would not be developed with the structures in place at that time. Shoaling problems were encountered in the crossing from the left bank below Island 21 toward the spur dikes, from along the spur dikes toward the left bank, and along the left bank in the bend.

59. With dike 6 in the river across the side channel, a continuous 10-ft channel had developed along the left bank from below Island 21 to below Wrights Point Bar along the concave side of the bend (Plate 16). Considerable dredging to depths of 20 ft was performed in October 1973 between miles 816.9 and 815.8. Scouring to depths of as much as 70 ft occurred downstream of the closure dike, causing some damage to the dike. By December 1974, dike 6 had been repaired and Dike 7 was constructed across the side channel downstream of dike 6 and 3 ft lower. Depths of scour below dikes 6 and 7 were as much as 75 and 34 ft, respectively. A good channel was maintained along the left bank. By June 1975, a wide 10-ft-deep channel existed along the left bank with depths of 20 to more than 30 ft indicated through most of the reach (Plate 17).

Discussion and Conclusions

60. In spite of the differences between the conditions in the model and those in the prototype at the time of construction of dike 6 and differences in the model and prototype dike, there were general similarities between actual developments in the river and model indications. The model indicated that there would be a greater tendency for the channel to develop along the left bank below Island 21 and for the channel to become deeper and wider with the closure dike. The model also indicated considerable scour below the closure dike. The river channel became deeper and wider with the closure dike and there was considerable scouring downstream and partial failure of the closure

dike. Since model test of the closure dike was started with the 1969 conditions and operated with only one reproduction of the hydrograph, the model channel was not fully developed during the test with a dike that was at least 6 ft lower than in the prototype and no dredging.

61. The second closure dike (dike 7) in the prototype was not included in the model test. Since the second dike was lower in elevation and downstream of the first dike, it would not contribute to the development of the channel. Its principal purpose was to reduce the head across the upper dike and improve its stability.

62. The degree of similarity between the results of the model study and developments in the river was mostly qualitative, particularly with tests of plans without the closure dike in the side channel. A direct comparison of the results of the model study of this reach with development in the river cannot be made because of the differences in the model reproduction of prototype conditions, omission of a base test, and effects of considerable dredging in the river. The model results did indicate the general effects of the proposed improvement plans tested when evaluated considering the limitations mentioned and also indicated that some of the tendencies were not fully developed with one reproduction of the hydrograph.

PART VIII: CRACRAFT-SARAH ISLAND REACH

Description of Prototype

63. The Cracraft-Sarah Island reach of the Mississippi River (miles 501-512) has been unstable and troublesome. It was complicated by divided flow resulting from sandbars and towheads or islands within the channel. The main channel formed four or five crossings and sharp bends that varied in alignment and depth depending on flow conditions. In 1968, the channel in the bend along the right bank revetment at mile 511 crossed toward the head of Carolina Towhead along the left bank at mile 510 and then crossed back toward the right bank at about mile 509 (Plate 18). From that point, the channel crossed back toward the left bank at about mile 506.5 with an elongated sandbar forming an island with elevations above 15 ft just downstream of the crossing. From the left bank, the channel crossed to the right toward the head of Sarah Island Towhead and split with the deeper channel making a sharp turn toward the right. The secondary channel along the left side of Sarah Island Towhead had depths of more than 10 ft, except near the lower end of the towhead in the crossing back toward the right bank where depths were about 5 ft or less. Except for the poor alignment, adequate depths were available in the channel crossing toward the right bank at the time of the June 1968 survey.

64. By June 1969, the crossing from Carolina Towhead toward the right bank at mile 509 had shoaled to <10 ft and the crossing toward the right bank near the head of Sarah Island Towhead had shoaled to above the ALWP. However, the channel to the left of Sarah Island Towhead had increased in width and depth and was more than adequate for navigation.

65. By July 1970, the channel along the left bank remained along that bank to about mile 501, eliminating several crossings toward and away from the right bank. At mile 508, there was considerable flow moving toward the right bank with river stages at about 14 ft, and the channel along the left bank had shoaled to less than 10 ft with a tendency to shoal near the head of Sarah Island Towhead.

The Model Study

Description of model

66. The model used in this study reproduced the reach between miles 500.5 and 514.5 to a horizontal scale of 1:480 and a vertical scale of 1:60. The purpose of the study was to obtain some general indications of the effectiveness of a system of spur dikes proposed for the improvement of the reach and the relative effectiveness of an alternate system using spur and vane dikes. Adjustment of the model was sufficient to provide only general indications of conditions that could be expected in the river. Results of the adjustment indicated that the sandbars and towheads were eroding more rapidly and the model channel was aggrading and generally deteriorating more than that indicated by the prototype surveys.

Improvement plans tested

67. Plans tested in the model included two and three spur dikes along the right bank between miles 510.3 and 509.0, designated as plans A and B, respectively. The upper two dikes (plan A) sloped from el 23 to 18 and from el 21 to 16 (bank to river) providing a stepped-down effect, and the river portions were angled toward the upstream. The third dike (plan B) was straight with its river end located about 5000 ft downstream of the end of the second dike and sloped from el 19 to 14 (Plate 19).

68. Plans C, D, and E involved the use of a spur dike with two, four, and six vane dikes, respectively, extending downstream of the river end of the spur dike (Plate 20).

Results

69. Results indicated that a reasonably good channel could be developed, particularly in the upper reach with the three spur dikes of plan B. The dikes were subjected to a strong current attack, and some modification in the layout and design of the dikes was indicated as desirable (Plate 19). Developments in the reach would depend to a considerable extent on flow conditions and the erodibility of the towheads and sandbars. There were indications that the crossing toward the

right bank below the dikes would tend to be unstable and affected by flow conditions.

70. Developments with one spur dike and six vane dikes (plan E) were generally similar to those obtained with plan B (Plate 20). The rate of development would tend to be slower with the vane dikes than with the spur dikes and would depend to some extent on the construction schedule. The spur dike would be subjected to a strong current attack which could be reduced by modification of the dike or addition of a shorter dike upstream. Although the attack on the spur dike affected the performance of the vane dikes, deposition landward and downstream was as much or more than that obtained with the spur dikes of plan B.

Prototype

Construction

71. During June-December 1970, Cracraft lower dikes 1R and 2R were completed based on the dikes of plan A of the model study. The dikes were 2 ft lower and somewhat shorter than those tested in the model and their alignments were modified. The third dike (3R) was under construction in 1971 based on plan B of the model study but was 2 ft lower and was angled upstream instead of being straight. This difference placed the river end of the third dike about 1500 ft closer to the end of the second dike and about 2100 ft farther upstream than that tested in the model. The modifications were designed to eliminate some of the adverse effects noted in the model tests.

River developments

72. Developments in the river indicated the need for the third spur dike. The effects of the dikes were noted, particularly with the erosion of Carolina Towhead, changes in the crossing from the left bank to the right bank, and erosion of Sarah Island Towhead. Scour holes on the ends of the Cracraft lower dikes were indicated by the April 1972 survey after a long period of medium flows but were not shown by later surveys. Deep scour holes developed near the bank ends of dikes 2R and 3R during and after the 1973 high water. Considerable deposition

occurred near the river portions of the lower two dikes and extended downstream of the dikes.

73. The deepest channel over the crossing from the right bank toward the left bank was upstream of the location of the ends of the proposed Cracraft lower dikes before construction and remained a considerable distance from the ends of the dikes after construction. With the dikes in place, the dispersion of flow toward the right bank was reduced and there was a rapid erosion of Carolina Towhead along the left bank downstream of the crossing. With erosion of the towhead, the channel below the crossing remained along the left bank down to about mile 506.5 and then crossed toward the head of Sarah Island Towhead.

74. Sarah Island Towhead was reduced considerably in size and elevation during the 1973 high water and almost completely disappeared during the 1974 high water. As the head and left side of the towhead eroded, the channel formed a bend to the left with a convex sandbar along the left bank. The general tendency was for the larger channel to follow along the left side of the remains of the towhead. As the head of the towhead receded, the channel along the right bank in the bend that had shoaled after construction of the Cracraft lower dikes began to increase in size and depth. This resulted in a divided channel but the deeper channel remained mostly to the left.

75. By the time of the last survey available for this study (May 1975), the crossing toward the left bank upstream of the Cracraft lower dikes had deteriorated appreciably and decreased in width opposite the upper Carolina dikes (Plate 21). The channel along the left bank at mile 506.6 crossed toward the right bank at mile 505. From that point, the channel formed across the sandbar to the left, bypassing the sharp bend in the right bank line. Sarah Island Towhead had practically disappeared except for a narrow strip with top elevations of 1 to 2 ft. There had been some scouring near the bank end of Cracraft lower dike 2R and a scour hole of some 50 ft in depth was indicated near the bank just downstream of dike 3R. Deposition to elevations of 20 to 30 ft extended from about 1600 ft upstream of the river portion of dike 2R across dike 3R to nearly 2 miles downstream.

Deposition over the top of dike 3R was as much as 10 ft higher than the dike.

Discussion and Conclusions

76. A comparison of the developments in the river with the model results indicates reasonably good agreement qualitatively, in spite of the differences in the dike systems and conditions imposed. The general points of agreement are summarized as follows:

- a. The attack on the dikes in the model indicated a need for modification of the system which was accomplished in the river with better results.
- b. The model indicated, as occurred in the river, that Carolina Towhead along the left bank and Sarah Island Towhead would be eroded with the dike system in place. The rate of erosion of the towheads was faster in the model, as would be expected.
- c. The model indicated that the crossing from along the left bank (Carolina revetment) toward the right bank would be moved downstream and that a sandbar would form along the left (convex) bank downstream of the crossing generally similar to what occurred in the river.
- d. The model indicated that the channel below the crossing from the left bank toward the right bank downstream of the dikes would be farther downstream and the channel would tend to follow that bank into the bend. In the river, the channel crossed toward the right bank but did not remain close to the bank by the time of the May 1975 survey. This development in the river was probably affected to some extent by the degree of erodibility of Sarah Island Towhead and the three successive long high-water periods.
- e. Model results and river developments indicated that the channel in the crossing toward the lower bend would be affected by flow conditions and could be unstable.

77. The model was not used to develop modifications that might have improved the performance of the dike system included in plan B. Some modifications were made in the dikes as constructed in the river and results indicate better performance than could have been expected with the dike system tested in the model. It should be noted that the dike system in the river, which included the stepped-down effect,

produced considerable deposition in between and downstream of the dikes which in some areas were 8 to more than 10 ft higher than the dikes. However, serious scouring occurred near the bank ends of the dikes.

78. Model study of plan E indicated that a system of vane dikes could have been developed which would have provided the same general results as those obtained with the spur dikes.

79. The alignment of the Cracraft lower dikes was such that the riverward portions of these dikes were angled toward the upstream. Developments in the river and to a lesser extent in the model indicated that the deeper channel in the crossing would remain a considerable distance from the ends of the dikes. This has been mentioned by some engineers as a characteristic of dikes angled upstream, but no conclusive evidence has ever been presented. In this case, the deep channel over the crossing was at the same location before construction of the dikes. More research is needed to obtain information on the performance and characteristics of these and other types of dike design and arrangement. The study should also be particularly concerned with the scouring near the bank ends of the dikes as occurred with the dikes in this reach of the river.

PART IX: KEYES POINT-FORKED DEER REACH

Description of Prototype

80. The Keyes Point-Forked Deer reach is that portion of the Mississippi River between miles 801.0 and 785.5. The reach at the time the study was undertaken (April 1968) was relatively straight for a distance of about 13 miles downstream of a sharp bend to the right with a wide secondary channel along the right bank (convex side) with controlling depths of more than 10 ft. At the lower end of this reach, there was a longer and more gradual bend to the left. The width of the channel, bank to bank, in the study reach varied from about 3000 ft in the upper reach to more than 7000 ft. Structures in the reach included the Forked Deer dikes on the left bank at mile 799.9, revetment along the right bank from mile 800.5 to 797.3, the Ashport Golddust and Kate Aubrey dikes on the right bank at miles 795.0 and 791.0, respectively, and revetment along the left bank from mile 794.5 to 789.1 (Plate 22). The reach had been generally unstable with a tendency to meander between the left bank and right bank dikes. The left bank was generally straight except for the lower reach which hooked to the right downstream of Keyes Point Towhead. The revetment on the left bank had failed at the lower end of the hook and was later repaired; about 2000 ft of the lower end of the repaired revetment also failed, and a deep channel developed landward of the revetment.

81. At the time of the November 1967 survey, the channel along the right bank revetment opposite the Forked Deer dikes crossed toward the left bank at about mile 797.0. The channel along the left bank then crossed toward the ends of the Ashport Golddust dikes and back toward the left bank at mile 793.3. From that point the channel followed the left bank to the crossing at mile 789.0, but had less than project depth at mile 790.2 opposite the end of Kate Aubrey dike 3. A deeper channel extended from the end of that dike toward the left bank. There was a tendency for a divided channel to form in the bend at mile 787 below the crossing.

82. By the time of the May-June 1968 survey, the crossing toward the left bank at mile 797.0 had shoaled to less than project depth. There was a tendency for the channel crossing from the left bank toward the ends of the Ashport Golddust dikes to shoal and for some increase in shoaling along the left bank at the upper end of the left bank revetment, mile 794.5. A shoal had formed opposite the end of Kate Aubrey dike 3 filling most of the deep channel indicated by the November 1967 survey. Shoaling was also indicated in the crossing toward the right bank at mile 788.5.

The Model Study

Description of model

83. The model reproduced the reach of the Mississippi River between miles 785 and 801 to a horizontal scale of 1:600 and a vertical scale of 1:60. The usual adjustment and verification of the model were not included in this study. However, some adjustments were made during the base test which was started with the bed molded to the survey of November 1967 and operated by reproducing a typical hydrograph similar to that shown in Plate 2. The base test was repeated with adjustments until developments in the model appeared to be reasonably typical of what could be expected in the prototype with the flow hydrograph reproduced.

84. Results of the final base test indicated a tendency for the model channel to aggrade compared with the prototype channel. The model channel along the right bank opposite the Forked Deer dikes, over the crossing toward the left bank, along the left bank and from the left bank toward the Ashport Golddust dikes was generally shallower than was indicated by the prototype survey. There were also changes in the alignment of the channel between the left and right banks and a tendency for the channel over the crossing toward the right bank at mile 788.0 to shoal.

Description of plans tested

85. Plans tested in the model included the following:

a. Test 1. Lower Forked Deer dikes 1 and 2 and dike 1U were added, and Ashport Golddust dikes 2AR and 4AR were extended about 2700 and 2850 ft, respectively.

b. Test 2. Lower Forked Deer dikes were 1000 ft upstream, Ashport Golddust dike 5 was added, and Ashport Golddust dike 4AR was shortened about 1800 ft.

c. Test 3. Ashport Golddust dike 6 was added at mile 792.5 and the river ends of dikes 4AR and 5 were modified.

d. Test 4. Keyes Point dikes 1, 2, and 3 were installed.

e. Test 5. Kate Aubrey dike 1 was extended and its river end was raised to el 13, and dike 3 was raised and extended.

f. Test 6. Forked Deer dike 3 on the left bank (mile 789.9) and Island 30 dikes 1, 2, and 3 on the right bank (mile 788.3-787.3) were added. A 900-ft length of Ashport Golddust dike 6 was removed on the bank end, and Lower Forked Deer dike 1 was lowered to el 12.

g. Test 7. Kate Aubrey dike 4 was added on the right bank (mile 789.3).

h. Test 8. Island 30 dikes were lowered 2 ft, and a 500-ft extension at el 5 was added to dike 1.

86. The plans tested were furnished by the U. S. Army Engineer District, Memphis, based on plans proposed for the reach and modified during the course of the study. The first test was undertaken with the bed of the model molded to the conditions indicated by the November 1967 survey and each succeeding test was started with the conditions as those obtained at the end of the preceding test.

Test results

87. During the first few tests of plans, there was a strong tendency for the model channel to be unstable, particularly over the crossing toward the left bank at mile 797 and along the left bank downstream. The addition of the Lower Forked Deer dikes and Ashport Golddust dike 1U (test 1) caused some increase in depths over the crossing. Later the crossing moved downstream and shoaled with the shifting of the Lower Forked Deer dikes upstream (test 2). During the remainder of the tests, the crossing changed in alignment but remained less than project depth, indicating little change from the results obtained with the base test.

88. Before the addition of the Keyes Point dikes, the channel along the left bank crossed toward the Ashport Golddust dikes on the right bank and then back toward the left bank upstream of Keyes Point Towhead. Also, the crossing from the left bank below the towhead toward the right bank maintained adequate depths and a good alignment (tests 2 and 3). After the installation of the Keyes Point dikes, the deeper channel along the ends of the Kate Aubrey dikes crossed toward the left bank below the Keyes Point dikes and back toward the right bank farther downstream (Plate 23). The model study was discontinued before a satisfactory plan for the reach was developed.

Prototype

Construction

89. Construction accomplished in the river after the model study was discontinued included the following:

- a. Forked Deer dike 3 was completed in December 1968, and dikes 4 and 5 were completed in January 1969.
- b. Ashport Golddust dike 1U was completed in January 1969. Modifications of dikes 2AR and 4AR and construction of dike 5 were completed during the period June-August 1969.
- c. Two sand spur dikes constructed of dredged material along the right bank at miles 788.4 and 788.2 were completed during the period July-September 1971.
- d. Keyes Point dikes 1, 2, and 3 were completed during the period October-December 1971, and dike 4 was completed during August 1974.

River developments

90. After construction of Forked Deer dikes 3, 4, and 5, there was a tendency for some scouring along the ends of the dikes and some shoaling along the right bank opposite the dikes. The channel along the left bank below the crossing at mile 797 tended to meander toward the right bank dikes and back toward the left bank generally similar to the conditions existing before modification of the Forked Deer and Ashport Golddust dikes (Plate 24). A channel of adequate depth had developed downstream of mile 792 by the end of 1971 with the

construction of the Keyes Point dikes, two sand dikes along the right bank (mile 788.3), and considerable dredging. However, during the following high water, the channel downstream of the crossing had shoaled in several locations with the deeper channel developing along the Kate Aubrey dikes.

91. The May-June 1975 survey indicated that the channel over the crossing toward the left bank between the Forked Deer and Ashport Golddust dikes was in good condition, but the channel crossing from the left bank toward the Kate Aubrey dikes had shoaled to controlling depths of less than 5 ft (Plate 25). Less than project depths were also indicated along the lower Keyes Point dikes even with the construction of dike 4 and dredging during 1974. In general, the prototype data indicated that an adequate channel would not be maintained with the dikes constructed during the period 1969-1974, although some improvement was produced in the channel over the crossing toward the left bank at mile 797.

Discussion and Conclusion

92. The reach reproduced in the model started just downstream of a large bend that had a large side channel. Since the model had to be started with a fixed reach, the effects of flow from the bend upstream which tends to vary with stage and discharge could not be reproduced naturally in the model. Considering the limitations of the study, the results provided some good general indications of the relative effectiveness of the various elements of the plans tested and of the trends that could be expected with the flow conditions reproduced.

93. The plans tested in the model were those considered for construction in the river. Results of the model study indicated that an adequate and stable channel would not be developed with the structures tested. The study did not include the investigation of any alternate plans or modifications from the proposed plan. By the time of the latest survey available (May 1975), a satisfactory channel had not been developed in the river with the plan tested and with Keyes Point dike 4

and considerable dredging not included in the model study.

94. It appears from a study of model and prototype data that problems encountered in this reach can be attributed mostly to the fact that it is a long straight reach between two bends with divided flow and wide top bank control up to 7500 ft. Although there have been several crossings in the straight reach, the crossings were rather short without typical or well-established bends and sandbars between crossings. This type of channel is susceptible to change with changes in stage and discharge and tend to be unstable.

PART X: ISLAND NO. 63 REACH

Description of Prototype

95. The Island No. 63 reach is that portion of the Mississippi River between miles 644 and 633. Island No. 63, located near the center of the reach at about mile 638, was formed when the Mississippi River cut through the point bar of Island No. 62 along the right bank. Since that time the cutoff channel between the two islands has been the main channel and the channel around the bend to the left of Island No. 63 decreased in width and depth.

96. By 1971, the right side of Island No. 63 forming the left bank of the main channel had been revetted from its upper to lower end and two dikes had been constructed across the entrance to the chute channel to further reduce flow in the channel to the left of the island (Plate 26). Four spur dikes, three vane dikes, and a long longitudinal dike were in place along the riverside of Island No. 62. With these structures in place, a satisfactory channel was maintained, with some dredging, past the island until the 1973 high water.

97. In 1973, the island was overtopped during the flood and scouring occurred behind the revetment causing it to fail (Plate 27). The failure of the revetment and its remains caused serious navigation problems because of shoaling, obstructions to flow, and adverse currents. Plans were developed for improvement of the reach which included realignment of the channel, training structures, and dredging. The model study was undertaken to determine the effectiveness of the proposed plan, part of which was under construction, and to develop modifications that might be required to produce and maintain a satisfactory channel through the reach.

The Model Study

Description of model

98. The model of the Island No. 63 reach reproduced the reach of

the river between miles 632.0 and 645.0 to a horizontal scale of 1:400 and vertical scale of 1:60. Before tests of plans were undertaken, the model was adjusted until it reproduced with reasonable accuracy the conditions in the river between the surveys of November 1971 and November 1972. Since a considerable change had occurred in the reach, caused by the 1973 flood and modifications made to assist navigation, the first test of improvement plans was started with the bed of the model molded to conform with the latest surveys in the reach (November 1973-May 1974). Each succeeding test was started with the model bed the same as that obtained at the end of the preceding test. The model was operated for each run by reproducing a composite annual hydrograph developed by the Memphis District based on a general review of flow conditions that had occurred in the reach during the 5-year period, 1966 to 1970.

Base test

99. The base test included the realigned channel and the following structures that were completed or under construction at the time (Plate 28):

a. Dredged channel along the realigned bank of Island No. 63 landward of the old revetted bank.

b. Dike 6-1/2L to el 25 at the bank end and sloping to el 15 at the channel end.

c. Dike 4-1/2R along the right bank with top el of 13.

d. Dike 5R to el 13 extending from the right bank across the chute channel and then sloping up to el 21 and maintained at that elevation to its river end.

e. Dike 6L, completed in the river and also included in the test, was at el 15 from the left bank across the chute channel, then sloped up and extended across the island at el 34 before sloping down to el 15 at the river end.

The portion of Island No. 63 behind the original revetment was molded in sand and was revetted when it was eroded to el 10 to simulate the effects of the old revetment remaining in the river.

100. Results shown in Plate 28 indicate that a channel of adequate width and depths of at least 20 ft was developed and maintained

through the entire reach after four reproductions of the hydrograph. A scour hole developed off the end of the dike 4AL similar to that indicated by the 1971 prototype survey and the verification test. Some flow was diverted through the shallow channel which angled to the right past the upper end of the remains of the old revetment (mile 638) and then followed the riverside of the vane dikes and dike 4D.

Tests of plan modifications

101. Nine modifications of the initial plan (base test), designated plans A to I, were tested in the model. These modifications involved mostly changes in the dike systems along the left bank at the head of Island No. 63 and in the dikes along the right bank.

102. Results of tests of the modifications to the initial plan indicated that a satisfactory channel could be developed and maintained with any of the plans tested. Channel depths and alignment would tend to be better with structures that extended from the right bank to the remains of the old revetment such as in plans G, H, and I which were designed to reduce flow moving to the right of the old revetment away from the main channel (Plate 29).

Prototype

Construction

103. After the 1973 flood, the damage near the head of Island No. 63 made navigation through the reach difficult and hazardous because of inadequate depths, poor alignment, and adverse currents. To assist navigation during the low-water period, considerable dredging was performed in the reach between Island No. 63 and the right bank dikes. Dredging was also undertaken to develop a new channel along Island No. 63 landward of the remains of the existing revetted bank. The new channel, completed by March 1974 with controlling depths of at least 10 ft, bypassed to the left the old revetted right bank of Island No. 63 remaining after the 1973 flood between miles 637.3 and 638.4. In addition to the dredging of a new channel, construction in the river by October 1974 included: dikes 4-1/2R and 5R along the right bank;

rock fill of dikes 5AL and 6AL along the left bank near the head of Island No. 63; and revetment on the riverside of Island No. 63 along the realigned channel. The channel just upstream of Island No. 63 had shoaled considerably and by March 1974 there was only a narrow 10-ft channel of irregular alignment and random areas of less than 10-ft depth.

River developments

104. By October 1974 the realigned channel had increased in width with controlling depths of more than 20 ft through the entire reach. There was still considerable flow diverted to the right, past the upper end of the remains of the old revetted bank (mile 638.4) as indicated by a wide shallow channel extending toward and along the vane dikes. During the period between the time of October 1974 survey and the October 1976 survey, a wide channel with more than adequate depth was indicated by all of the periodic surveys of the reach without any further construction (Plate 30). Although some of the total flow was diverted toward the vane dikes, and during high stages over dikes 4-1/2R and 5R along the right bank, the diversion was not sufficient to adversely affect developments in the main channel as realigned with the flows experienced during that period.

Discussion and Conclusions

105. The model used for the study of the Island No. 63 reach did not have as high a distortion of the linear scales as most of the other models covered herein. Also, considerable time was used in adjusting the model, and a reasonably good verification of conditions in the prototype prior to the 1973 flood was obtained. Because of the model adjustment and the use of a hydrograph that was more typical of the reach under study than was used in the other studies, the model base test not only indicated the general trends that could be expected with improvements scheduled for completion in 1974, but also indicated very closely the controlling depths in the main channel as they actually developed and maintained in the river at least up to the time of the

latest available survey (October 1976).

106. Developments in the realigned channel could be affected by the location and amount of flow diverted to the right past the remains of the old revetment. Model results and developments in the river indicated that with flows reproduced in the model and those experienced in the river during the period 1974-1976, the flow diverted would not be sufficient to have any adverse effects on conditions within the main channel. The amount of flow diverted will depend to some extent on river stages, condition of the remains of the old revetment, and condition of the right bank dikes 4-1/2R and 5R. Since side channels tend to take a greater sediment load in proportion to the discharge, the existing channel to the right past the upper end of the old revetment should continue to be shallow.

107. Since the model and prototype developments indicated that modifications of the original plan were not needed, none of the modifications tested in the model were included in the construction program in the river.

PART XI: DISCUSSION AND CONCLUSIONS

Model Studies

108. The model studies covered herein were designed and conducted to obtain some quick indications as to the effectiveness of the plans proposed for the improvement of some of the more troublesome and complicated reaches of the Mississippi River. The plans tested were proposed by the sponsoring office and in some cases modified during the course of the study in collaboration with representatives of the offices concerned. In most cases, construction had already been scheduled or was in progress at the time the model studies were undertaken. Because of the construction schedules for the various reaches, time did not permit the use of the conventional type of movable-bed model studies on any of the reaches.

109. All of the model studies were conducted in an existing facility that was limited in size and shape. The model horizontal scales varied from reach to reach as required to reproduce the essential features of the reach being studied and depended on the length, width, and alignment of the reach. The distortion of the linear scales (horizontal and vertical) varied from 6 to 10.83 which is considerably higher than would normally be used in studies of this type. Even with the high distortion, the hydraulic forces were not sufficient to move the model bed material (sand) in simulation of movement of sediment in the prototype without some exaggeration of the velocity scales.

110. Distortion of the linear scales produces a difference in the width-depth ratio of the model channel from that of the prototype, and exaggeration of the velocity scale produces some changes in the alignment of currents and in the proportional amount of lateral differential in water level. Because of these and other dissimilarities, the reliability of movable-bed models has to be based on verification of the model. Except in the case of the Island No. 63, adjustment of the models was limited by the time available and in some cases was omitted almost entirely. An important factor that has to be considered in the

adjustment is the rate of introducing bed material in simulation of the rate of sediment moving into the prototype reach from upstream which varies from reach to reach and with stage and discharge. If not properly adjusted, the model channel would aggrade or degrade with respect to the prototype channel and could affect the location, alignment, and depth of the low-water channel and the amount and type of deposition, particularly in reaches that tend to be unstable. The effects could be cumulative if several runs are made without remolding the model bed to an existing prototype condition as was the case in most of these studies. The model results could also be affected when reproducing prototype reaches that have gravel bars, remnants of old structures and islands, towheads, and old sandbars that have varying degrees of erodibility, the extent of which is generally not known, and are difficult to simulate in the model.

111. In the evaluation of the results of movable-bed model studies, the limitation of the model in reproducing prototype conditions as indicated by the verification of the model and the effects of the flow hydrograph on developments as indicated by the base test have to be considered. Use of the results of tests of improvement plans as obtained from the model without considering all of the factors involved and conditions imposed on the model could lead to conclusions not warranted by the results of the study. In comparing model indications with developments in the river, the differences in flow conditions, differences between plan tested and that constructed in the river, and the effects of any dredging in the prototype not reproduced in the model have to be considered. Also, all model surveys were made after a substantial high-water period and should compare more closely with prototype surveys made after a high-water period than those made after a low-water period.

112. The comparison of model results with prototype developments indicate that these types of models predicted, at least qualitatively, most of the principal trends that actually occurred in the river with the plans tested. The degree of accuracy of the models varied and depended to a considerable extent on the accuracy of the model

adjustment, characteristics of the reach, flow conditions, and similarity between plans tested and actual construction. The greatest differences between model and prototype trends were obtained in the study of the Island 21-Wrights Point reach. In this case, the model indicated some deposition and reduction in flow in the side channel that did not occur in the prototype with the plan tested. This model was not in good adjustment as indicated by the tendency for the model channel to degrade with some shoaling in the side channel not indicated by the prototype surveys available at that time. The reach was affected by the pile dikes, permeability, and condition and amount of stone fill which were not adequately defined. The model did indicate the need and effectiveness of the closure dike across the side channel and the tendency for scouring below the dike.

113. The most accurate prediction of conditions that actually occurred in the river was obtained with the model of the Island No. 63 reach. This model was in good adjustment before tests of plans were undertaken and the flow hydrograph used was more indicative of the flow that actually occurred in the river than the hydrograph used in the other studies. As a result, the model reproduced almost quantitatively conditions that developed in the river up to October 1976. In the Keyes Point-Forked Deer reach, the model indicated that none of the plans tested would produce a satisfactory channel. In the prototype, a satisfactory channel had not developed in that reach by the end of the study period, even with additional construction and considerable dredging. In the Caruthersville-Linwood Bend reach the plan proposed and tested had not been completed in the river and a direct comparison between model and prototype could not be made. The model indicated that all of the structures as proposed for that reach would be required to develop a satisfactory channel around the concave side of the bend. The portion of the plan completed in the river did not produce the desired results even with considerable dredging, although some improvements were indicated.

114. Because of the complex nature of alluvial streams, the effectiveness of plans proposed for improvement of troublesome reaches

cannot always be determined by analytical means. Although the conventional type of movable-bed model studies would generally provide better results, the types of studies described herein can be valuable in providing some general indications of the results that can be expected from a particular plan and the need for modifications at less cost than with the conventional type of studies. Experience with these studies indicates the need for model adjustment, evaluation of model results based on the accuracy of the adjustment, and the use of a flow hydrograph that would be more representative of flow conditions which can be expected in the reach under study than the hydrograph used in most of the tests.

Prototype Analysis

115. Comparison of model indications with prototype developments required the analysis and evaluation of considerable prototype data. This analysis provided an opportunity to evaluate the performance of various types of structures and plans and developments within the reaches of the river investigated. Some of the observations and indications based on the analyses of available prototype data are outlined below.

116. The initial plans for the improvement of the Choctaw Bar reach and the Island 21-Wrights Point reach were generally similar and were designed to effect a side channel closure by diverting sediment into the channel with a system of spur and vane dikes. The plan was successful in the Choctaw Bar reach but not in the Island 21-Wrights Point reach. There were significant differences in the two reaches and in the structures that have to be considered. The curvature of the bend at Choctaw Bar was little more than 90 deg while that at Wrights Point Bar was about 180 deg. The length of the side channel compared with the length of the channel around the bend at Wrights Bar was much less than that at Choctaw Bar and carried considerably more flow, exceeding 50 percent during some river stages. The spur dikes in the Wrights Point reach were pile dikes with various amounts of stone fill

providing a stepped-up effect on the dike farthest downstream instead of stone dikes with some stepped-down effect as in the Choctaw Bar reach. Also, the line of vane dikes at Wrights Point Bar was started some distance landward of the river end of the last spur dike rather than at the end.

117. Two closure dikes were placed across the side channel at Wrights Point Bar. With the first dike, severe scouring developed below the dike with partial failure of the dike which was typical of the difficulties encountered in maintaining other side-channel closures. The drop in water-surface elevation across the structure was indicated to be more than 4 ft during some flows. A second closure dike was then constructed some distance downstream with a top elevation 3 ft lower than that of the first dike. Some scouring occurred below the second dike but was considerably less than had occurred at the first dike. The maximum drop in water-surface elevation across the two dikes appeared to have been divided almost equally between the two dikes.

118. When flow is diverted through a side channel, the low-water channel will tend to develop toward the point of diversion. This tendency was demonstrated in most of the reaches studied, particularly those with side channels across the convex side of bends. Where there was substantial flow through the side channel in the bend, the low-water channel generally crossed from the convex side (point of diversion) toward the concave bank, approaching the bank at a rather sharp angle. The channels over these crossings were mostly unstable and generally of poor alignment. The tendency for channels to develop toward the point of diversion was demonstrated more vividly when the Mississippi River channel moved from the left bank to the right bank after the Old River control structure was placed in operation on the right side.

119. The reaches studied included various types of dikes and provided some indications of their performance which are outlined below:

> a. Spur dikes. Most of the spur dikes were constructed with some stepped-down effect in elevation. The Baleshed dikes and Wrights Point dikes (pile dikes with stone fill) had the stepped-up effect. Very little, if

any, deposition was indicated between these dikes and there was scouring below some of the dikes during the period investigated, particularly the dikes farthest downstream. Water level upstream of each of the stepped-up dikes tends to be higher than that in the adjacent channel when the dike upstream is overtopped, creating a lateral differential that may tend to cause sediment to move away from the dike. The dike farthest downstream in a stepped-up system tends to be less stable than in a stepped-down system because of the higher head and greater scour.

b. Dike angle. Most of the spur dikes were angled slightly toward the downstream or placed normal to the channel alignment. The Cracraft lower dikes had most of their riverward portions angled toward the upstream. Some engineers have indicated that dikes angled toward the downstream will tend to attract the channel toward the dikes while dikes angled upstream will tend to cause the channel to move away from the dikes. The channel over the crossing remained some distance away from the ends of the Cracraft lower dikes which tends to support the above statement. Since the channel was in about the same location as before the dikes were constructed, further study of these dikes would be required before definite conclusions can be reached.

c. Vane dikes. Vane dikes were included in plans for the improvement of several of the study reaches. The performance of these dikes varied considerably, depending on their location and arrangement with respect to the other structures and flow conditions. Severe scouring developed on the ends and downstream of one or more of the dikes in each system during some flows and scouring disappeared during other flows. Vane dikes were generally placed across side channels downstream of one or more spur dikes. Flow diverted by the spur dikes tends to move back toward the vane dikes rather than at a slight angle, particularly when the spur dikes are not overtopped. With flow moving toward the vane dikes, the dikes act as obstructions to flow resulting in the scour on the ends and downstream. In the case of the Ben Lomond dikes, differences in water level from the right bank to the left bank across the vane dikes were as much or more than 1.0 ft during low flows and decreased to about 0.3 or 0.4 ft during high flows. The differences across the Wrights Point vane dikes had to be much greater. The Ben Lomond vane dikes were used to cause deposition in the deep channel along the alignment proposed for the construction of long spur dikes, thus reducing the height of the dikes. Most of

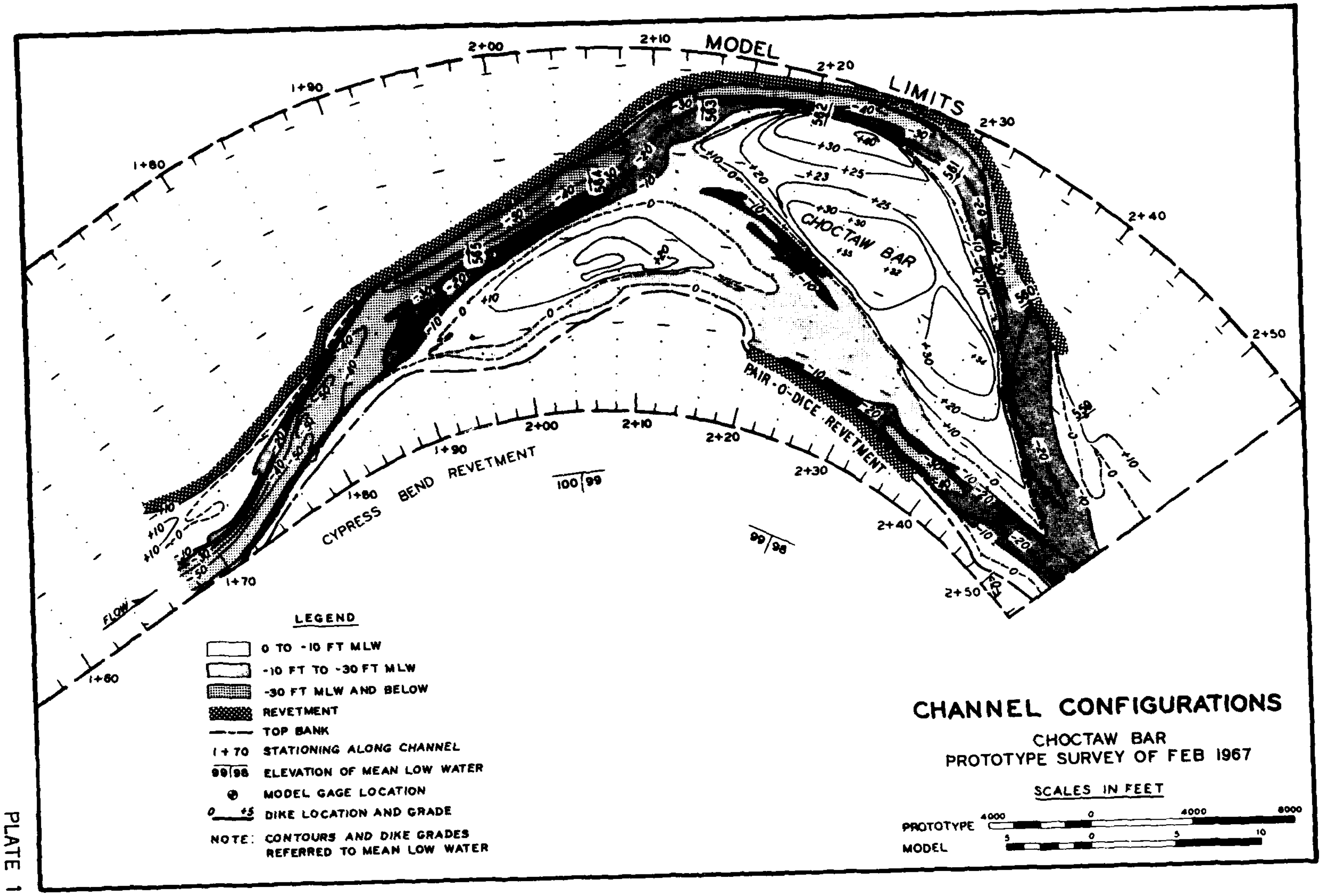
the deposition occurred when the spur dikes upstream of the vane dikes were overtopped.

120. Differences in the water-surface elevations measured along the concave bank of bends indicated slopes up to more than 1.6 ft/mile. The differences in water level which varied within the bend with river stages had to be mostly the effect of superelevation of the water surface rather than a true indication of the longitudinal slope or head losses along the bank.

121. Most of the reaches studied had long straight reaches between alternate bends. The low-water channel in these reaches tended to meander between the channel control limits and be generally unstable.

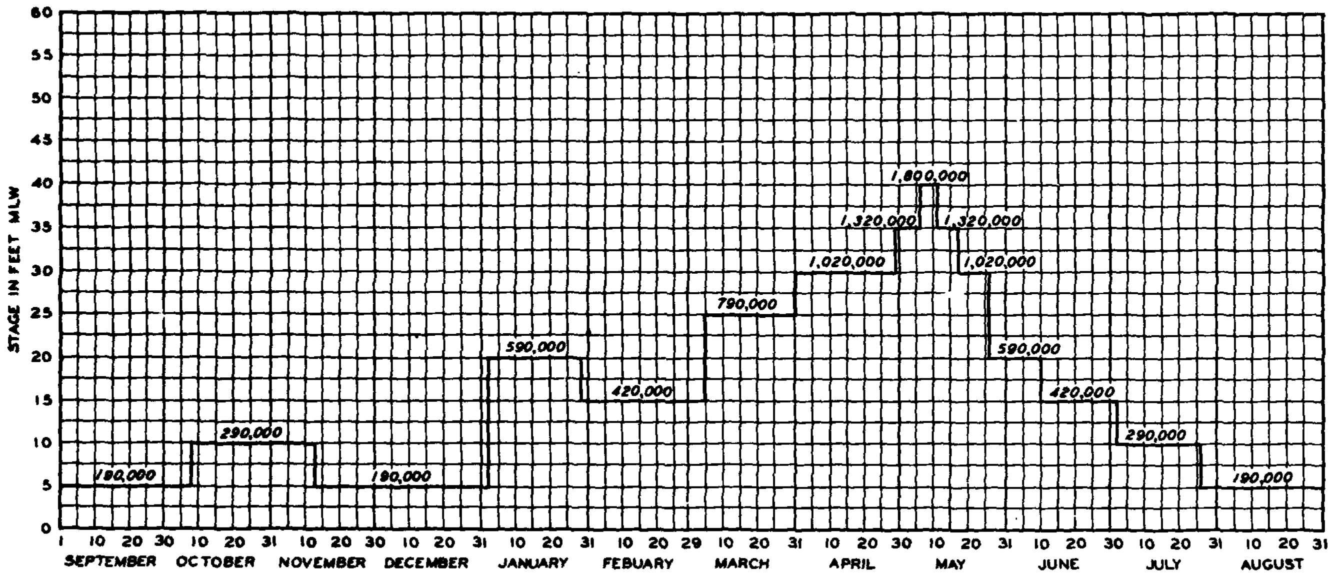
122. Side channel closure structures have been difficult to maintain because of the head over the structures and severe scouring downstream. Results with the Island 21-Wrights Point reach indicate how the total drop in water level through a side channel can be distributed between two or more closure structures with each succeeding structure at a lower elevation than the one upstream. The head across each structure would depend on the total drop in water level through the channel, number of structures, controlling elevation of each, and length of the structures at the controlling elevation.

123. A large number of dredge cuts, many of which were of an emergency nature to provide depths for navigation, were made in several of the reaches studied. Some of the cuts shoaled within a short time after completion and many after a substantial change in river stages. The effectiveness of dredge cuts on channel development depends on their location and alignment with respect to the natural trends of the river. Selection of the best location for a dredge cut is extremely difficult, particularly in reaches that tend to be unstable, since conditions are constantly changing with changes in flow conditions. Cuts made where there is a natural tendency for shoaling will tend to act as a sediment trap and be filled within a short time. The placement of dredged material within the channel can also affect development and its effects, particularly with regard to the channel downstream, should be considered.



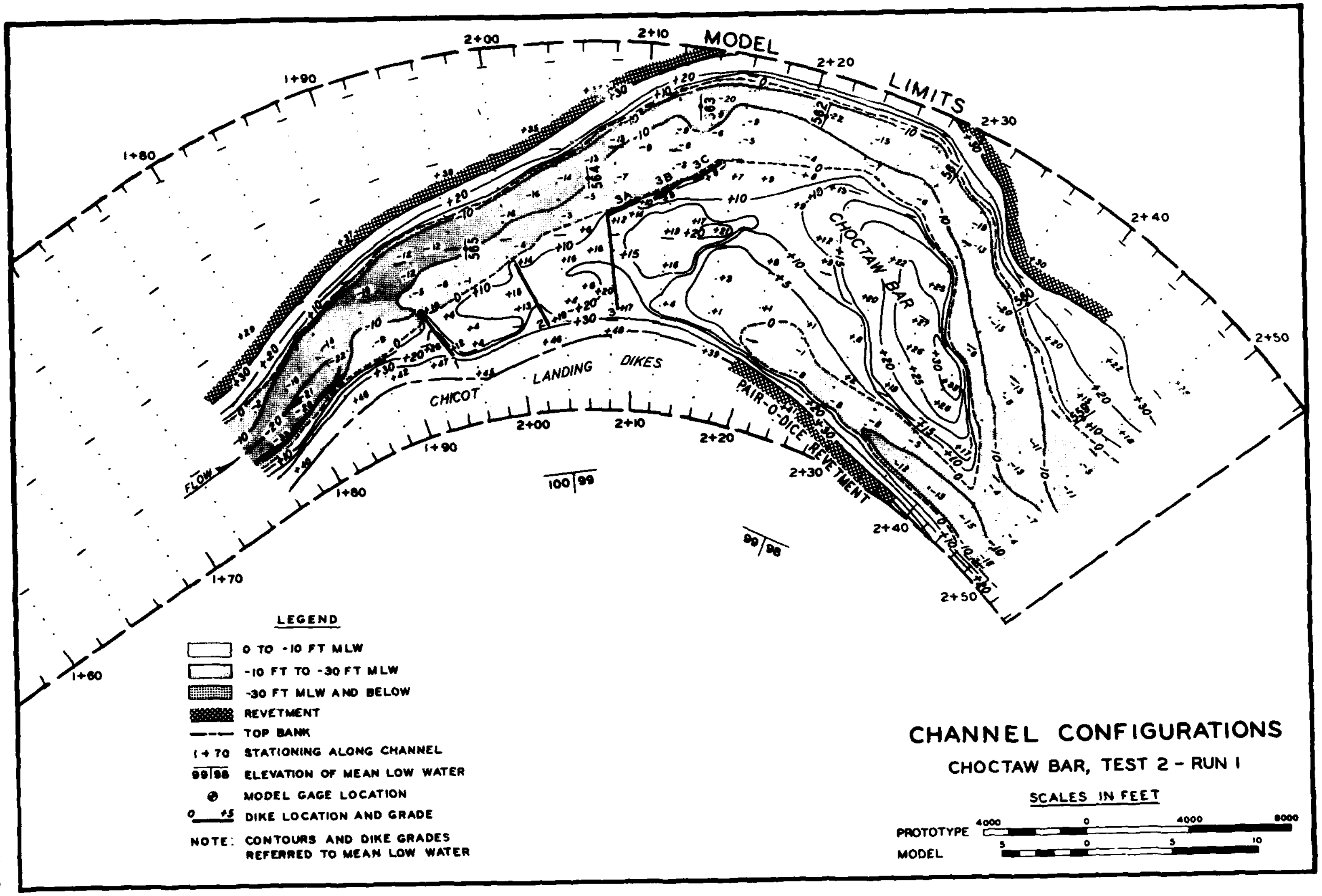
CHANNEL CONFIGURATIONS
CHOCTAW BAR
PROTOTYPE SURVEY OF FEB 1967

PLATE 1



NOTE: VALUES SHOWN ON HYDROGRAPH ARE PROTOTYPE DISCHARGE IN C.F.S.

MODEL
STAGE HYDROGRAPH



CHANNEL CONFIGURATIONS

CHOCTAW BAR, TEST 2 - RUN 1

PLATE 3

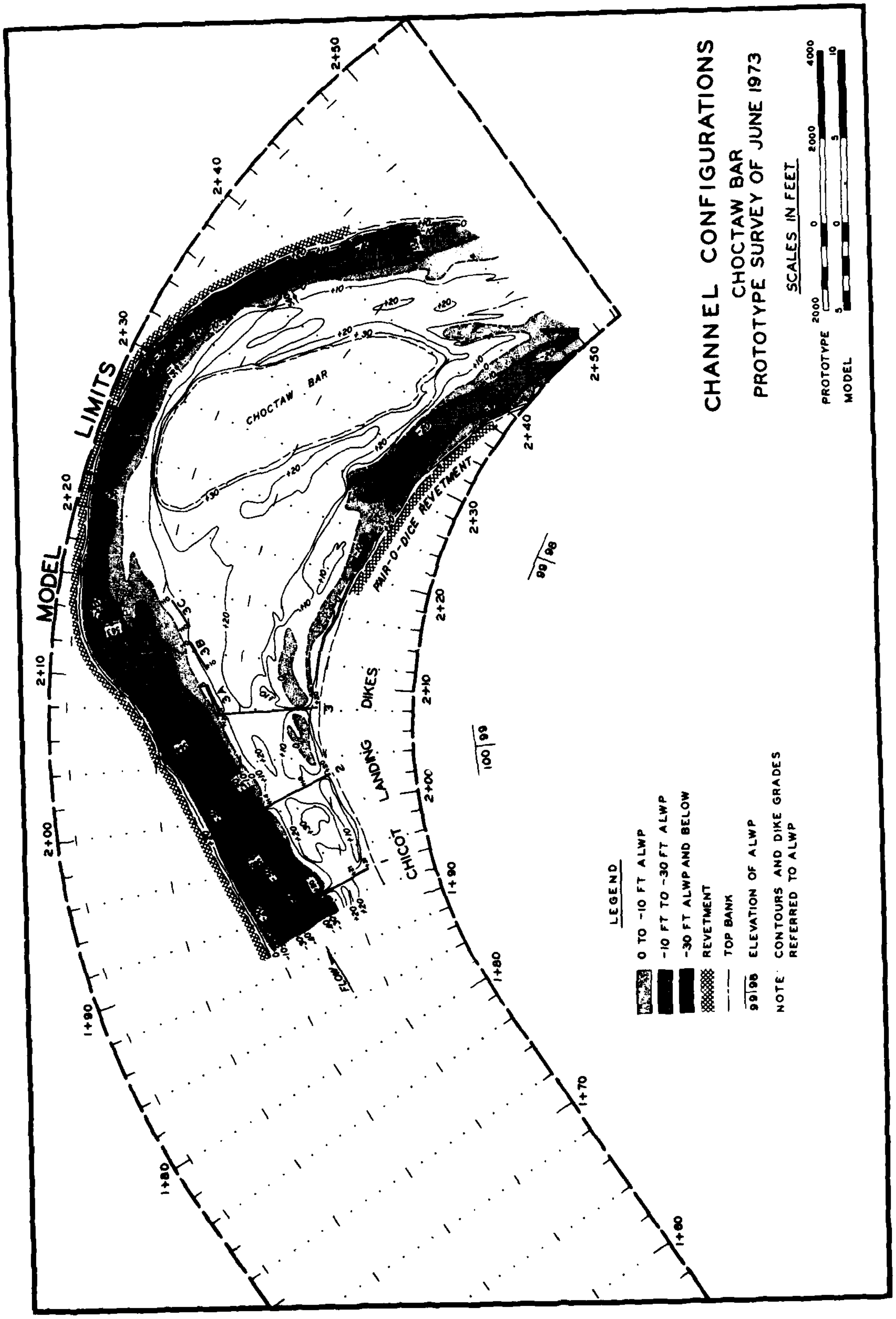

CHANNEL CONFIGURATIONS
CHOCTAW BAR
PROTOTYPE SURVEY OF JUNE 1973
SCALES IN FEET
PROTOTYPE 2000 0 2000 4000
MODEL 5 0 5 10
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
TOP BANK
99|98 ELEVATION OF ALWP
NOTE: CONTOURS AND DIKE GRADES REFERRED TO ALWP
MODEL LIMITS
CHOCTAW BAR
CHICOT LANDING DIKES
PAR-O-DICE REVETMENT
FLOW
100|99
99|98

PLATE 4

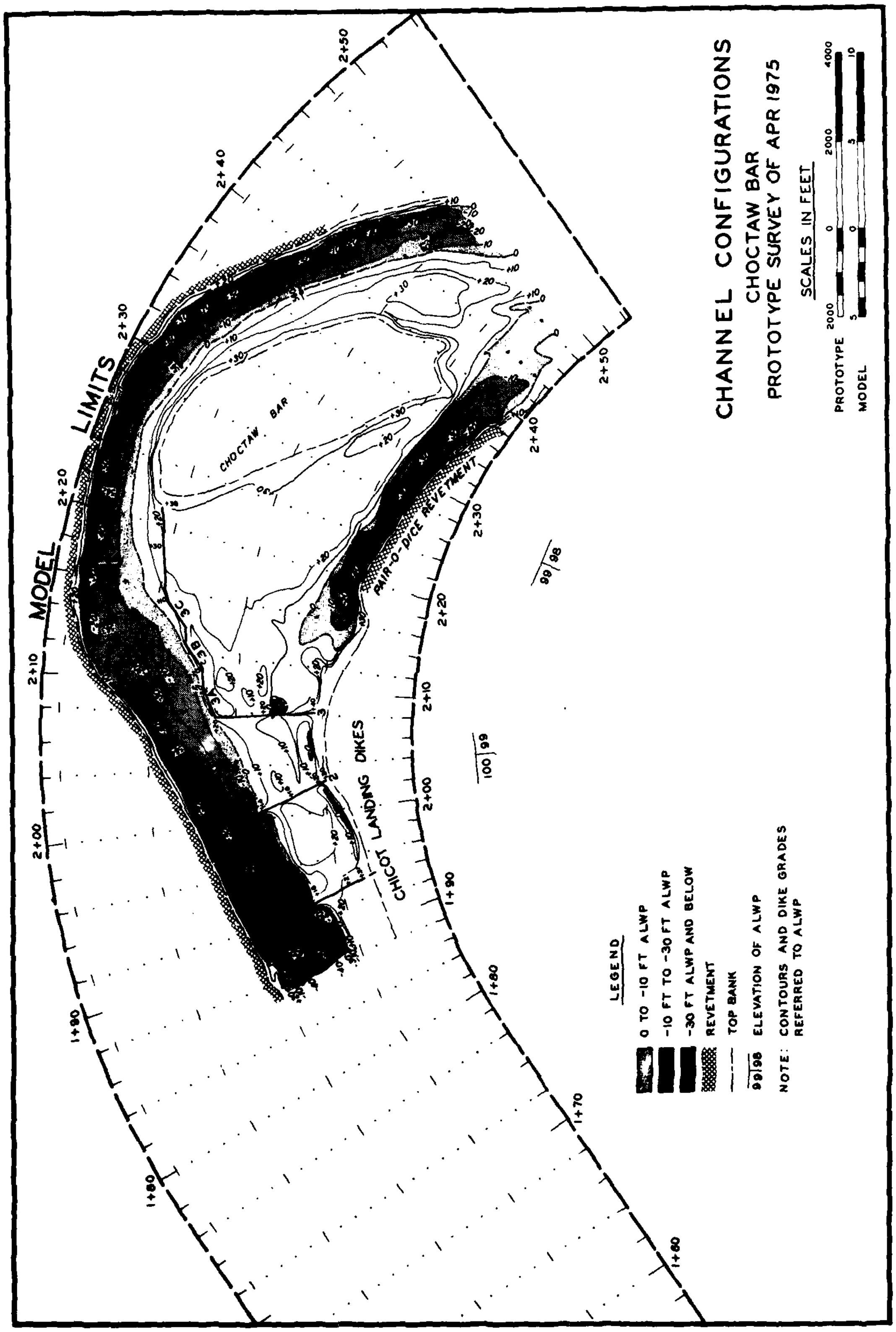

CHANNEL CONFIGURATIONS
CHOCTAW BAR
PROTOTYPE SURVEY OF APR 1975
SCALES IN FEET
PROTOTYPE 2000 0 2000 4000
MODEL 5 0 5 10
MODEL LIMITS
CHOCTAW BAR
PAIR-O-DICE REVETMENT
CHICOT LANDING DIKES
99/98
100/99
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
TOP BANK
99/98 ELEVATION OF ALWP
NOTE: CONTOURS AND DIKE GRADES REFERRED TO ALWP

PLATE 5

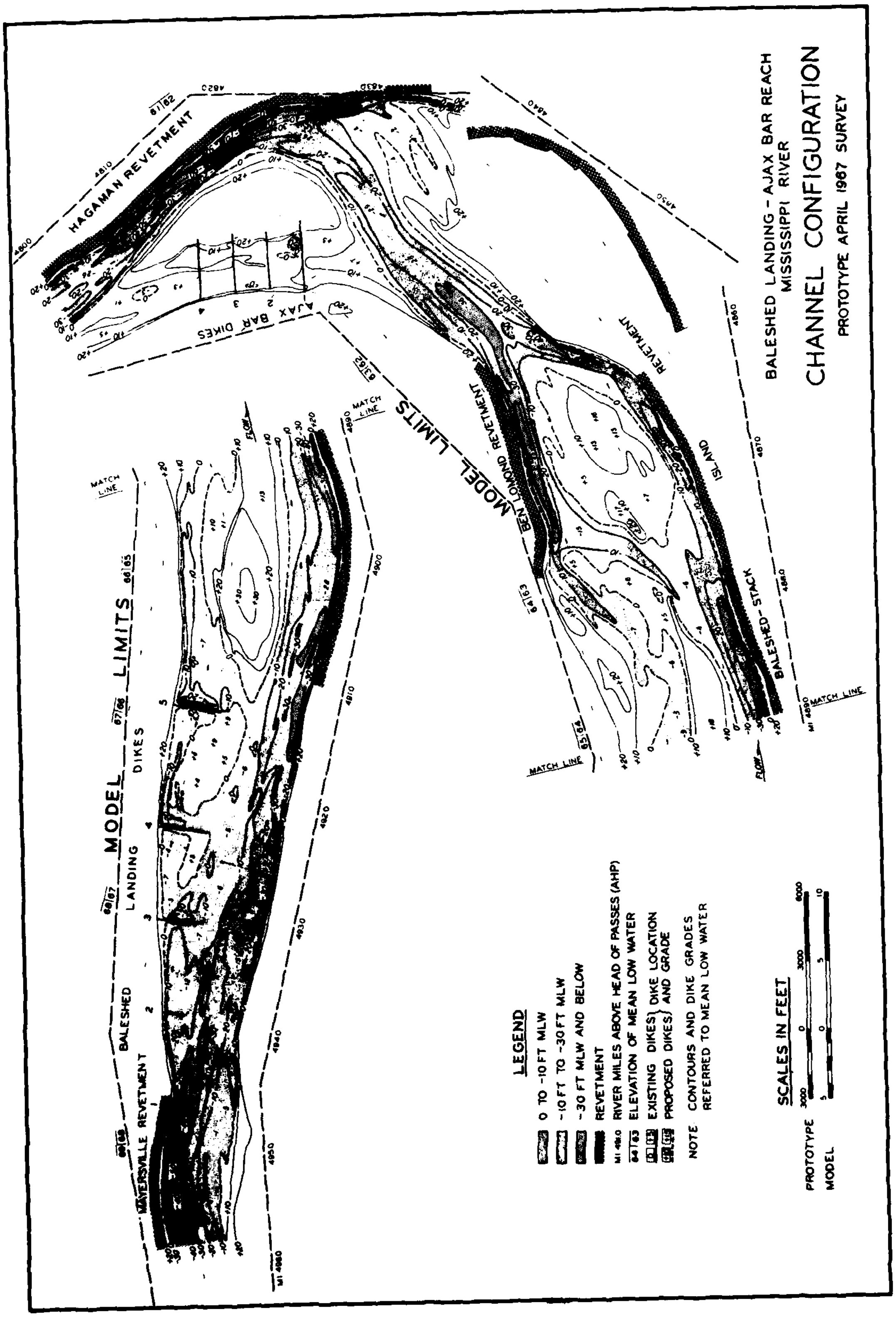
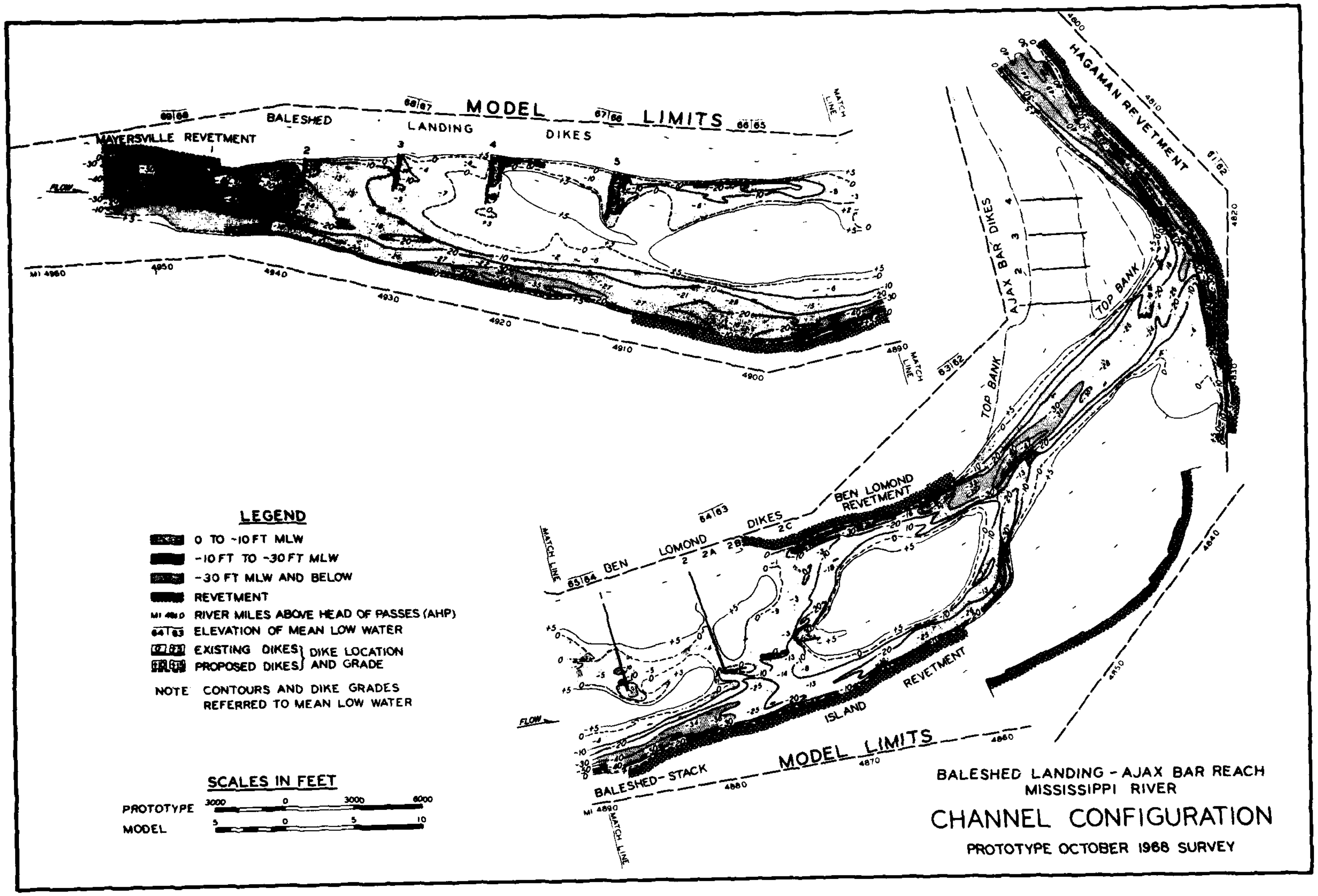

BALESHED LANDING - AJAX BAR REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE APRIL 1967 SURVEY
HAGAMAN REVETMENT
AJAX BAR DIKES
MODEL LIMITS
BEN LOMOND REVETMENT
REVETMENT
ISLAND
BALESHED-STACK
MATCH LINE
FLOW
MODEL LIMITS
BALESHED LANDING DIKES
MAYERSVILLE REVETMENT
LEGEND
0 TO -10 FT MLW
-10 FT TO -30 FT MLW
-30 FT MLW AND BELOW
REVETMENT
MI 490.0 RIVER MILES ABOVE HEAD OF PASSES (AHP)
64163 ELEVATION OF MEAN LOW WATER
EXISTING DIKES} DIKE LOCATION
PROPOSED DIKES} AND GRADE
NOTE CONTOURS AND DIKE GRADES REFERRED TO MEAN LOW WATER
SCALES IN FEET
PROTOTYPE 3000 0 3000 6000
MODEL 5 0 5 10

PLATE 6



BALESHED LANDING - AJAX BAR REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE OCTOBER 1968 SURVEY
MODEL LIMITS
MAYERSVILLE REVETMENT
BALESHED LANDING DIKES
HAGAMAN REVETMENT
AJAX BAR DIKES
TOP BANK
BEN LOMOND REVETMENT
BEN LOMOND DIKES
ISLAND REVETMENT
BALESHED-STACK
MATCH LINE
FLOW
LEGEND
0 TO -10 FT MLW
-10 FT TO -30 FT MLW
-30 FT MLW AND BELOW
REVETMENT
RIVER MILES ABOVE HEAD OF PASSES (AHP)
ELEVATION OF MEAN LOW WATER
EXISTING DIKES
PROPOSED DIKES
DIKE LOCATION AND GRADE
NOTE CONTOURS AND DIKE GRADES REFERRED TO MEAN LOW WATER
SCALES IN FEET
PROTOTYPE 3000 0 3000 6000
MODEL 5 0 5 10

PLATE 7

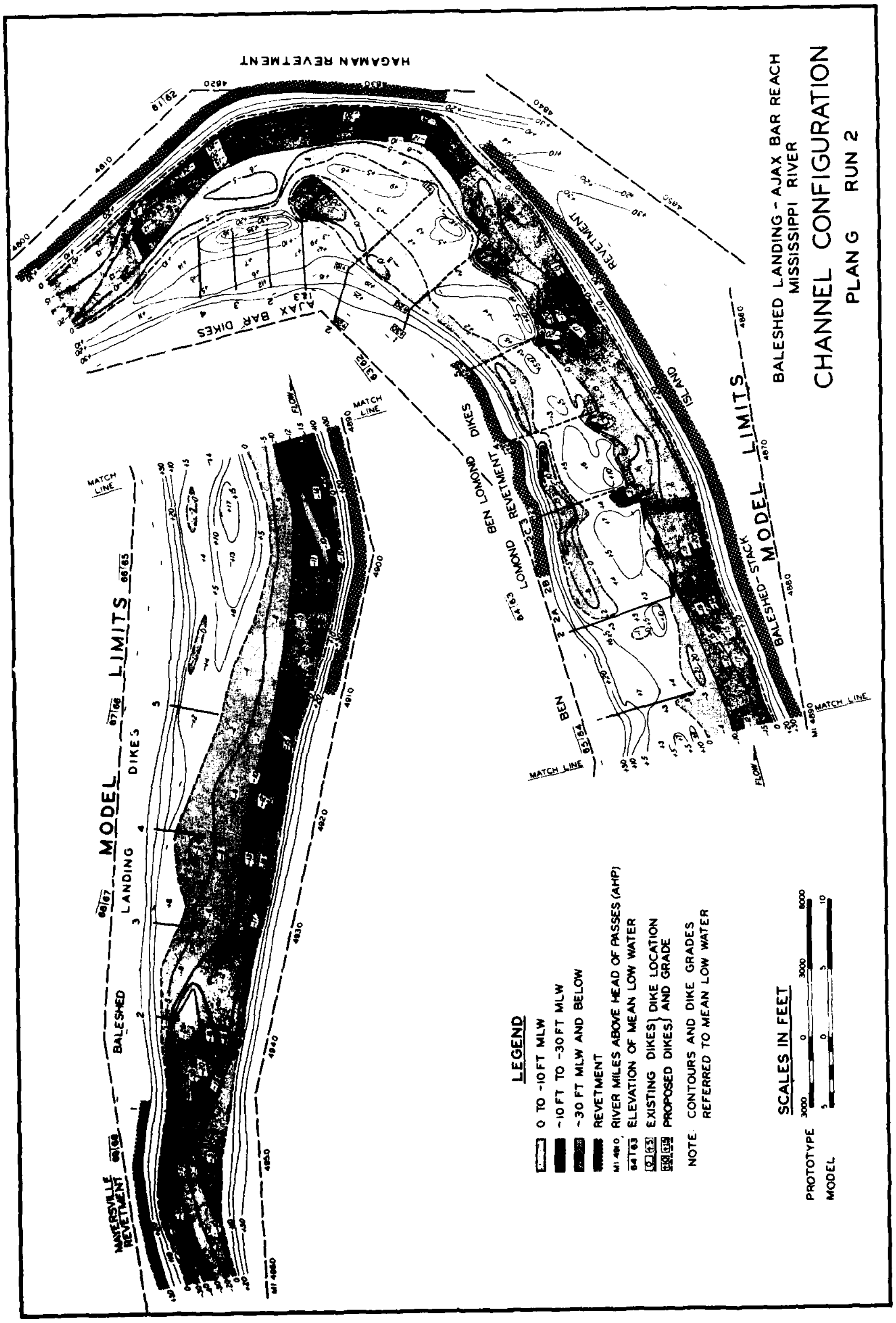
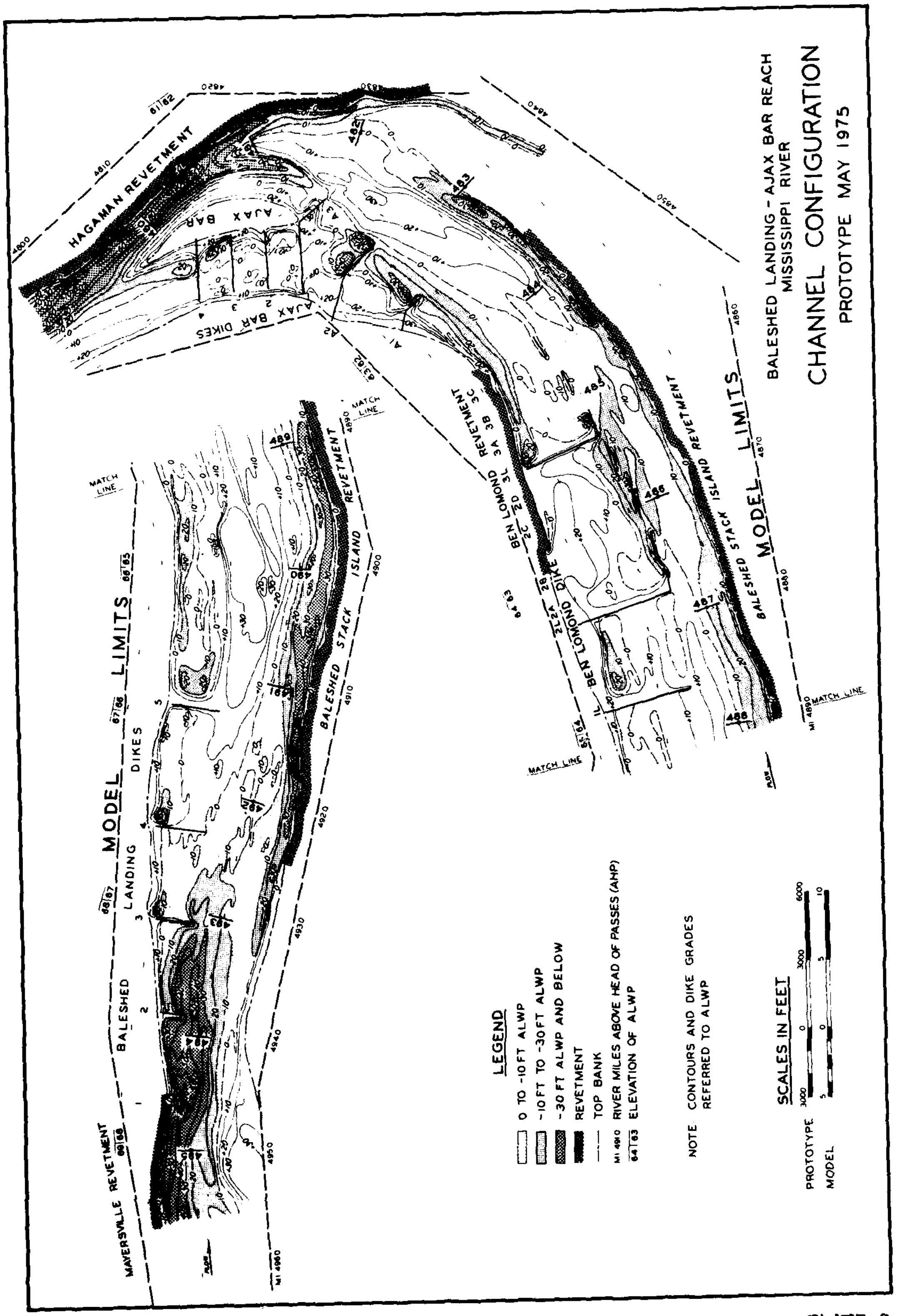
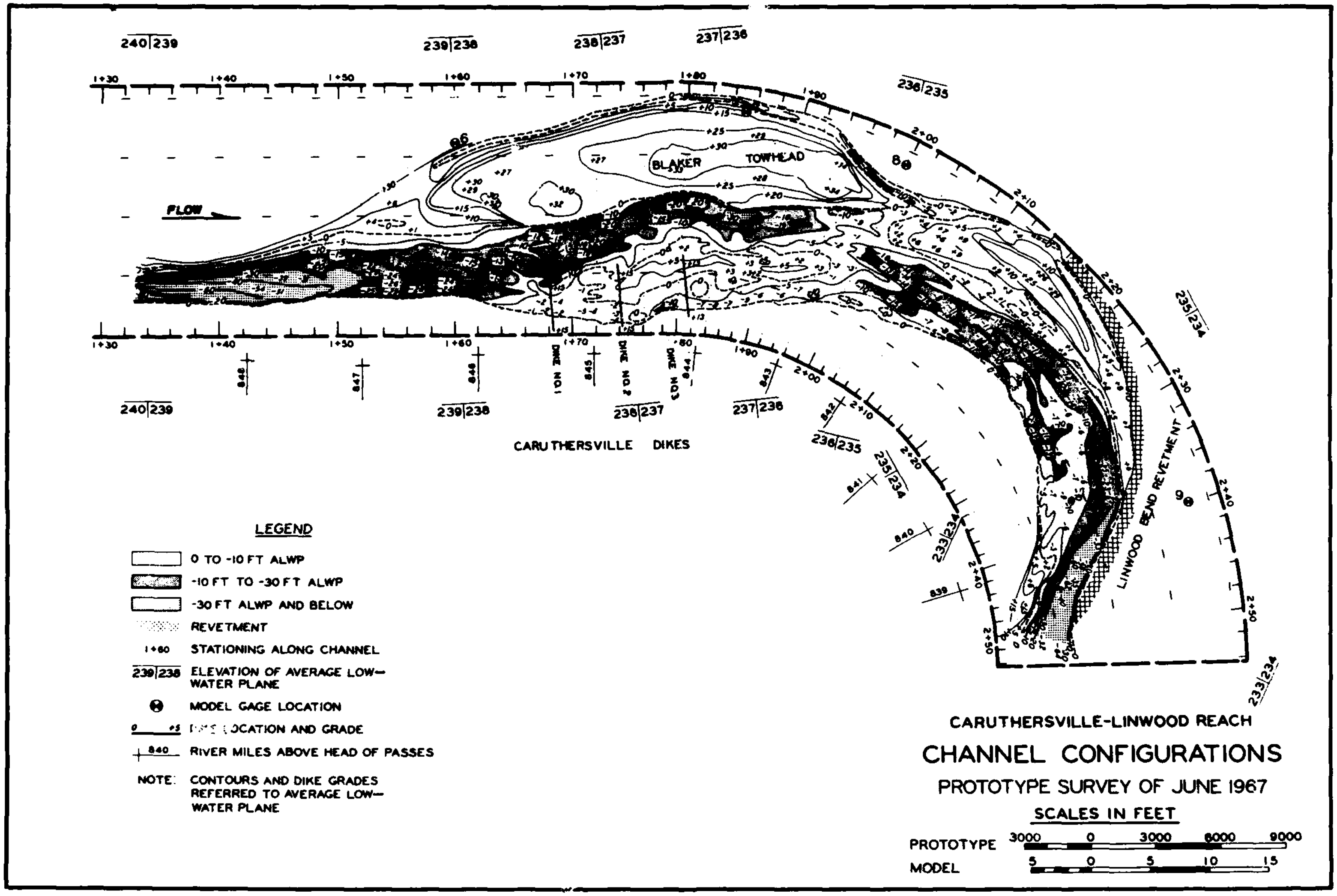

BALESHED LANDING - AJAX BAR REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PLAN G RUN 2
HAGAMAN REVETMENT
AJAX BAR DIKES
BEN LOMOND DIKES
BEN LOMOND REVETMENT
ISLAND REVETMENT
BALESHED-STACK
MODEL LIMITS
BALESHED LANDING DIKES
MODEL LIMITS
MAYERSVILLE REVETMENT
MATCH LINE
FLOW
LEGEND
0 TO -10 FT MLW
-10 FT TO -30 FT MLW
-30 FT MLW AND BELOW
REVETMENT
MI 4810 RIVER MILES ABOVE HEAD OF PASSES (AHP)
64 63 ELEVATION OF MEAN LOW WATER
EXISTING DIKES
PROPOSED DIKES
DIKE LOCATION AND GRADE
NOTE CONTOURS AND DIKE GRADES REFERRED TO MEAN LOW WATER
SCALES IN FEET
PROTOTYPE 3000 0 3000 6000
MODEL 5 0 5 10

PLATE 8



BALESHED LANDING - AJAX BAR REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE MAY 1975
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
TOP BANK
MI 490 RIVER MILES ABOVE HEAD OF PASSES (AHP)
64.63 ELEVATION OF ALWP
NOTE CONTOURS AND DIKE GRADES REFERRED TO ALWP
SCALES IN FEET
PROTOTYPE
MODEL
MODEL LIMITS
HAGAMAN REVETMENT
AJAX BAR
AJAX BAR DIKES
BEN LOMOND REVETMENT
BEN LOMOND DIKE
BALESHED STACK ISLAND REVETMENT
BALESHED LANDING DIKES
MAYERSVILLE REVETMENT
MATCH LINE

PLATE 9

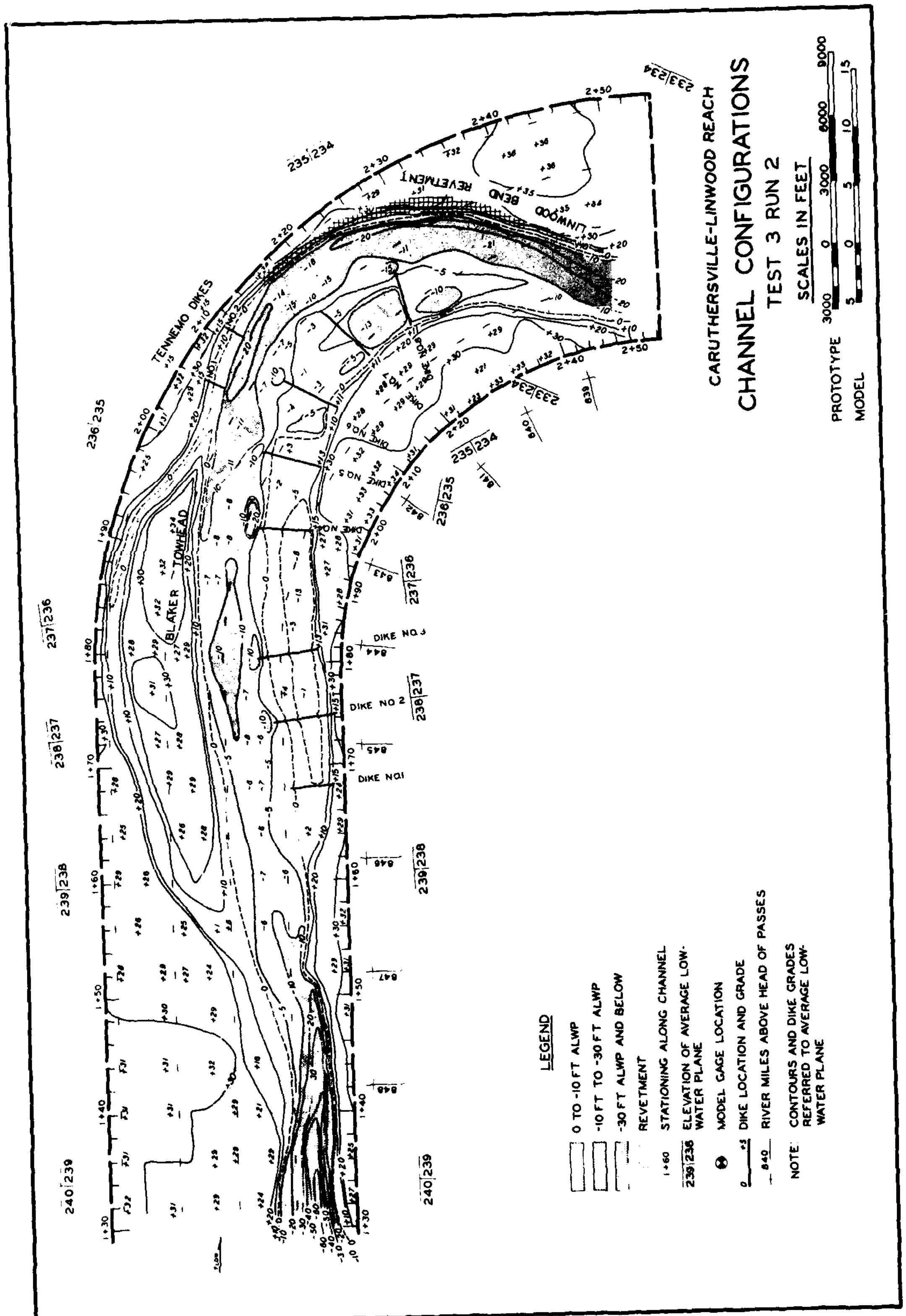


CARUTHERSVILLE-LINWOOD REACH

CHANNEL CONFIGURATIONS

PROTOTYPE SURVEY OF JUNE 1967

PLATE 10



CARUTHERSVILLE-LINWOOD REACH
CHANNEL CONFIGURATIONS
TEST 3 RUN 2
SCALES IN FEET
PROTOTYPE 3000 0 3000 6000 9000
MODEL 5 0 5 10 15
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
1+60 STATIONING ALONG CHANNEL
239|238 ELEVATION OF AVERAGE LOW-WATER PLANE
MODEL GAGE LOCATION
DIKE LOCATION AND GRADE
840 RIVER MILES ABOVE HEAD OF PASSES
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE
TENNEMO DIKES
BLAKER TOWHEAD
LINWOOD BEND REVETMENT
DIKE NO 1
DIKE NO 2
DIKE NO 3
DIKE NO 5

PLATE 11

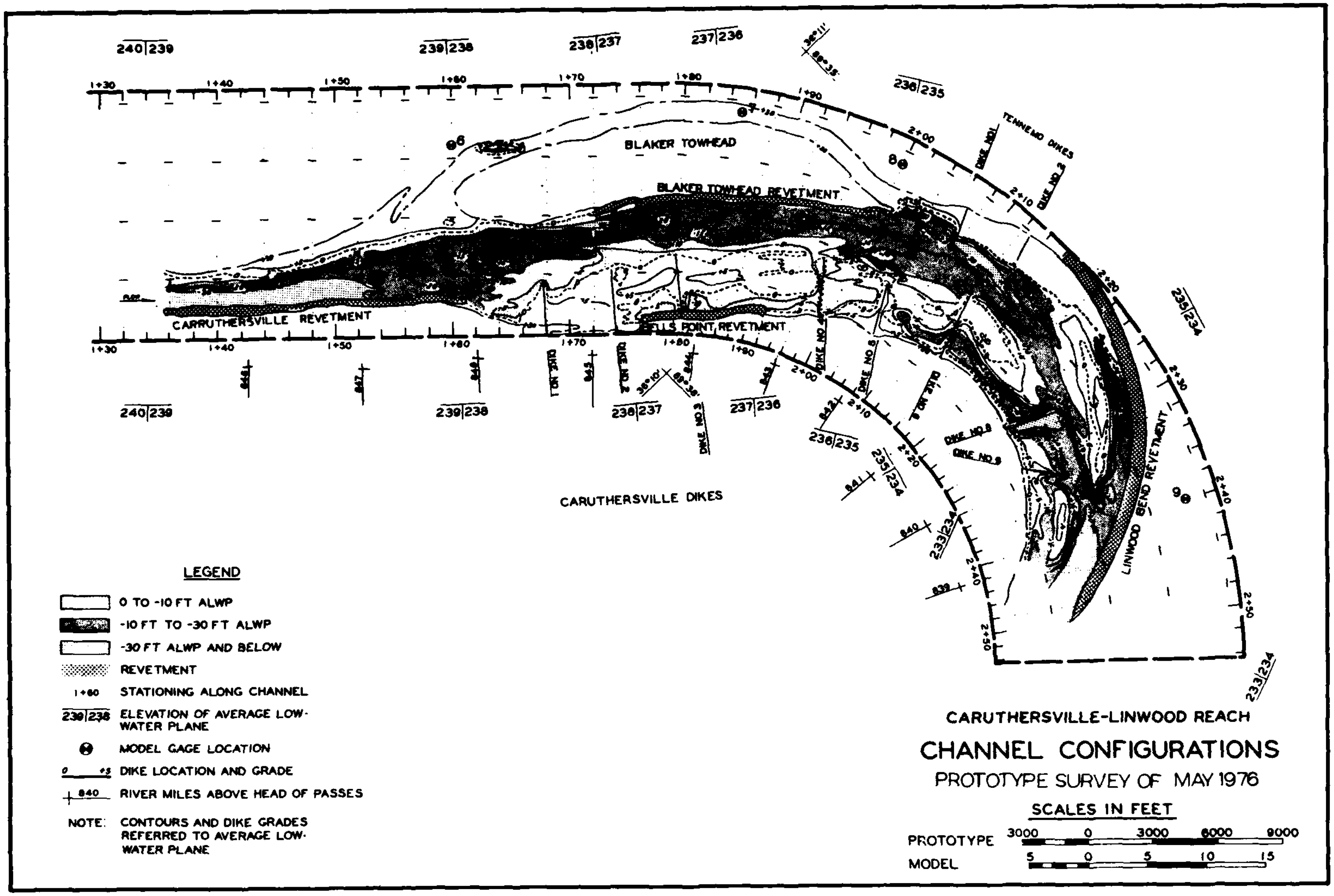

CARUTHERSVILLE-LINWOOD REACH
CHANNEL CONFIGURATIONS
PROTOTYPE SURVEY OF MAY 1976
SCALES IN FEET
PROTOTYPE 3000 0 3000 6000 9000
MODEL 5 0 5 10 15
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
1+60 STATIONING ALONG CHANNEL
239|238 ELEVATION OF AVERAGE LOW-WATER PLANE
MODEL GAGE LOCATION
DIKE LOCATION AND GRADE
840 RIVER MILES ABOVE HEAD OF PASSES
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE
BLAKER TOWHEAD
BLAKER TOWHEAD REVETMENT
CARRUTHERSVILLE REVETMENT
BELLS POINT REVETMENT
CARUTHERSVILLE DIKES
TENNEMO DIKES
LINWOOD BEND REVETMENT
DIKE NO 1
DIKE NO 2
DIKE NO 3
DIKE NO 4
DIKE NO 5
DIKE NO 6
DIKE NO 8
DIKE NO 9
240|239
239|238
238|237
237|236
236|235
235|234
233|234

PLATE 12

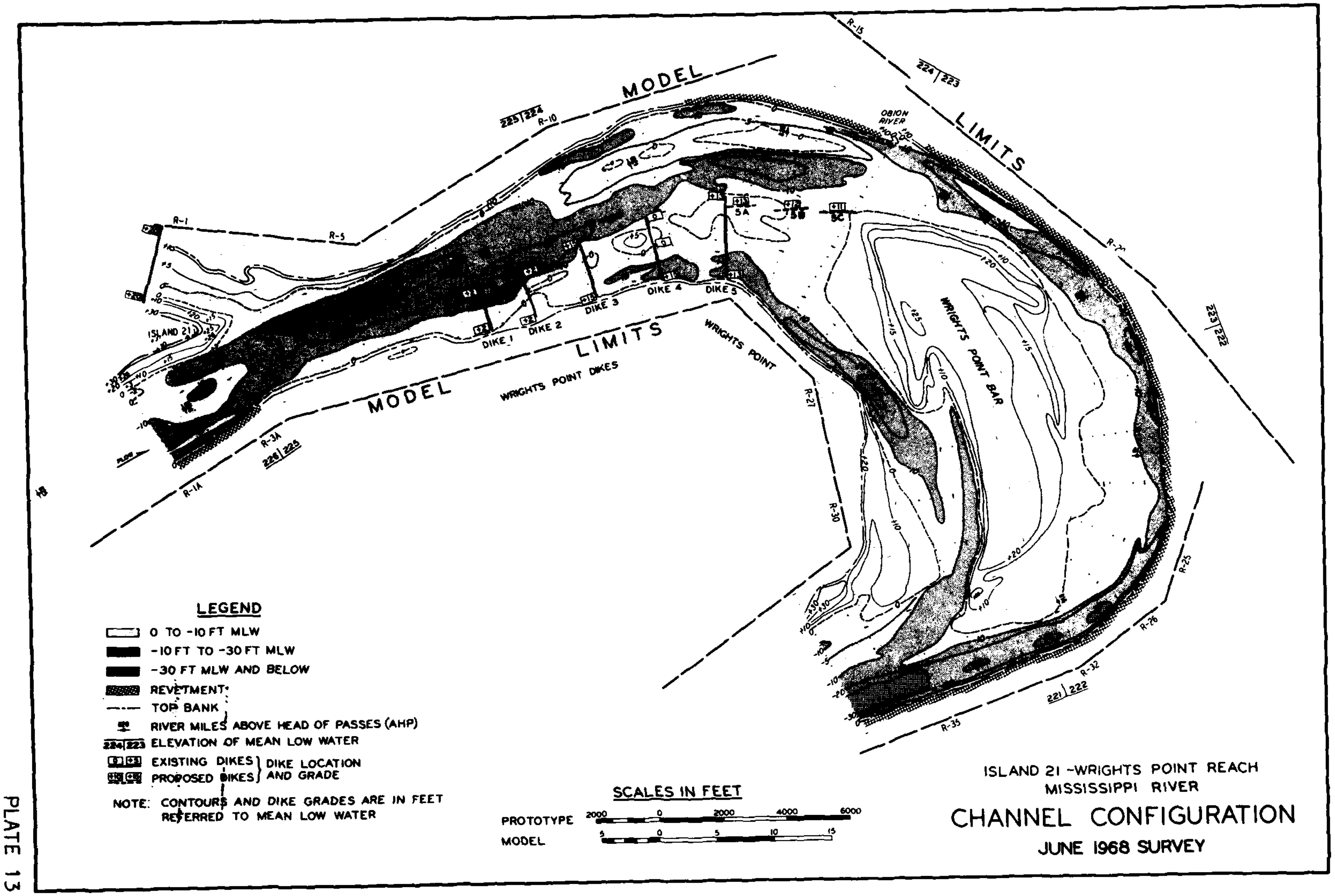

ISLAND 21 - WRIGHTS POINT REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
JUNE 1968 SURVEY
LEGEND
0 TO -10 FT MLW
-10 FT TO -30 FT MLW
-30 FT MLW AND BELOW
REVETMENT
TOP BANK
RIVER MILES ABOVE HEAD OF PASSES (AHP)
ELEVATION OF MEAN LOW WATER
EXISTING DIKES } DIKE LOCATION
PROPOSED DIKES } AND GRADE
NOTE: CONTOURS AND DIKE GRADES ARE IN FEET REFERRED TO MEAN LOW WATER
SCALES IN FEET
PROTOTYPE 2000 0 2000 4000 6000
MODEL 5 0 5 10 15
MODEL LIMITS
MODEL LIMITS
WRIGHTS POINT BAR
WRIGHTS POINT
WRIGHTS POINT DIKES
DIKE 1
DIKE 2
DIKE 3
DIKE 4
DIKE 5
5A
5B
5C
ISLAND 21
OBION RIVER
FLOW
R-1
R-1A
R-3A
R-5
R-10
R-15
R-20
R-25
R-26
R-27
R-30
R-32
R-35
225|224
224|223
223|222
221|222
226|225

PLATE 13

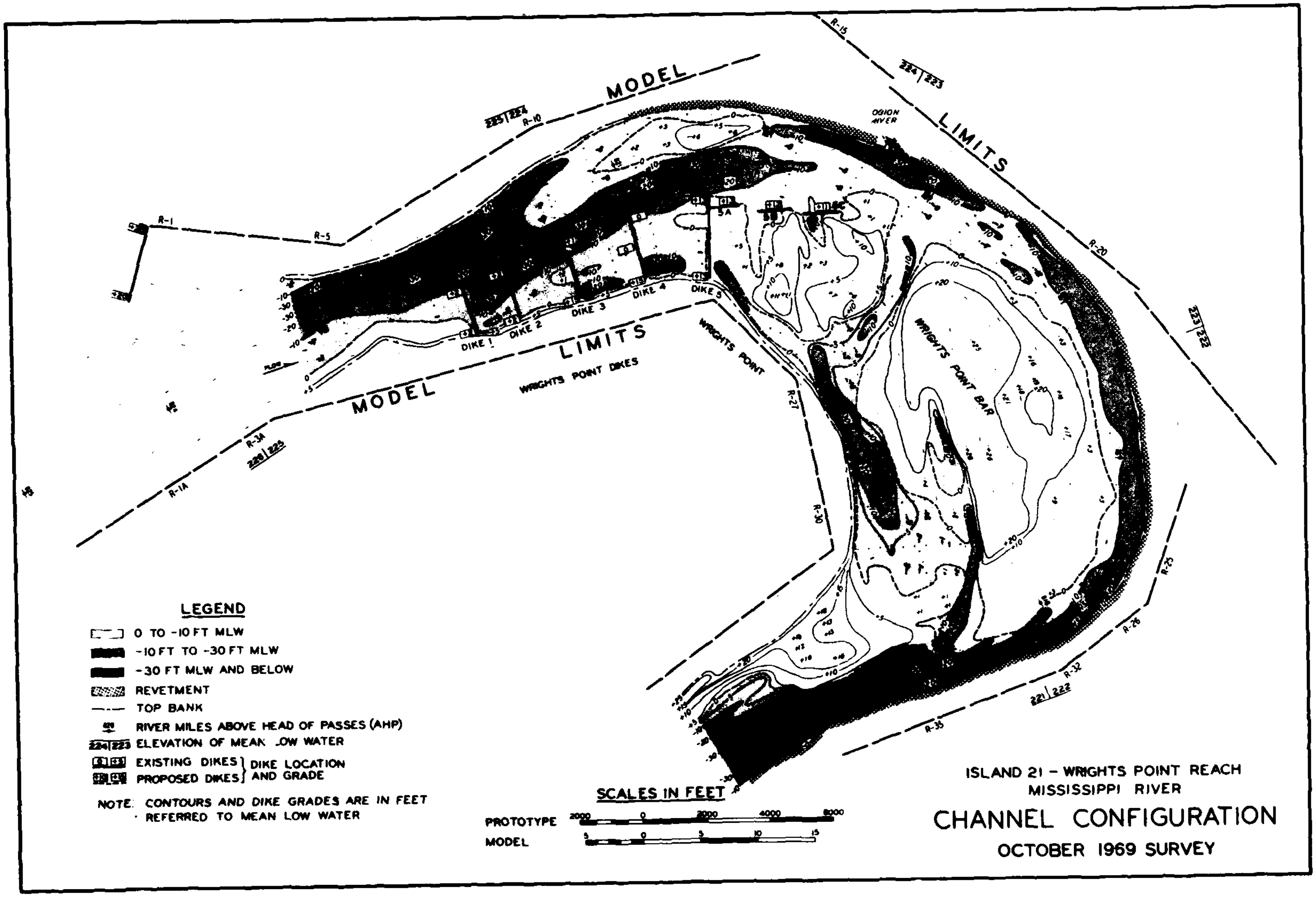
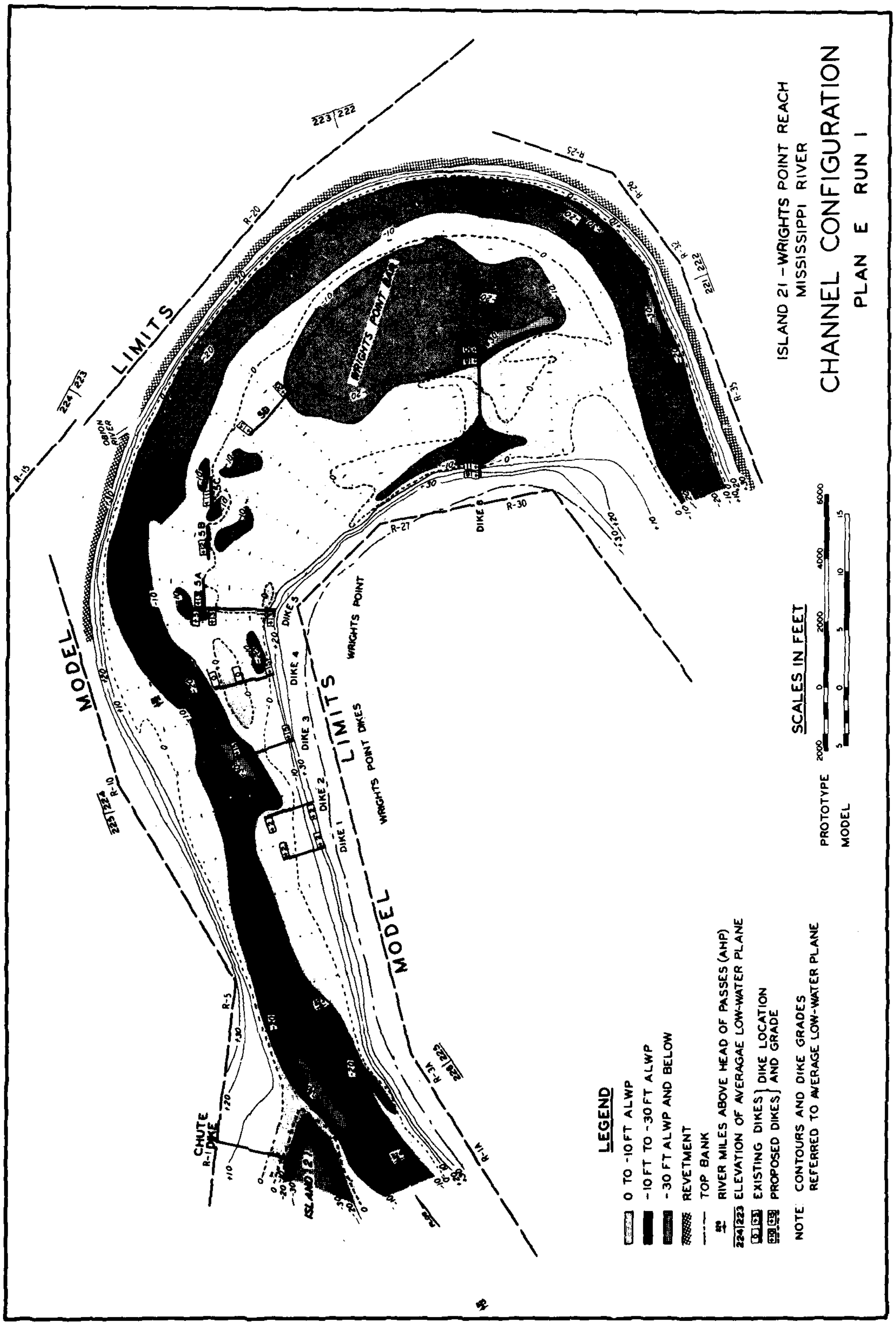

MODEL LIMITS
MODEL LIMITS
ISLAND 21 - WRIGHTS POINT REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
OCTOBER 1969 SURVEY
WRIGHTS POINT BAR
WRIGHTS POINT
WRIGHTS POINT DIKES
OBION RIVER
DIKE 1
DIKE 2
DIKE 3
DIKE 4
DIKE 5
5A
R-1
R-5
R-10
R-15
R-20
R-25
R-26
R-27
R-30
R-32
R-35
R-1A
R-3A
225|224
224|223
223|222
221|222
226|225
LEGEND
0 TO -10 FT MLW
-10 FT TO -30 FT MLW
-30 FT MLW AND BELOW
REVETMENT
TOP BANK
RIVER MILES ABOVE HEAD OF PASSES (AHP)
ELEVATION OF MEAN LOW WATER
EXISTING DIKES
PROPOSED DIKES
DIKE LOCATION AND GRADE
NOTE: CONTOURS AND DIKE GRADES ARE IN FEET REFERRED TO MEAN LOW WATER
SCALES IN FEET
PROTOTYPE 2000 0 2000 4000 8000
MODEL 5 0 5 10 15

PLATE 14


ISLAND 21 - WRIGHTS POINT REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PLAN E RUN I
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
TOP BANK
RIVER MILES ABOVE HEAD OF PASSES (AHP)
ELEVATION OF AVERAGAE LOW-WATER PLANE
EXISTING DIKES
PROPOSED DIKES
DIKE LOCATION AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE
SCALES IN FEET
PROTOTYPE
MODEL
MODEL LIMITS
MODEL LIMITS
WRIGHTS POINT BAR
WRIGHTS POINT
WRIGHTS POINT DIKES
ISLAND 21
CHUTE DIKE
DIKE 1
DIKE 2
DIKE 3
DIKE 4
DIKE 5
DIKE 8
ORION RIVER

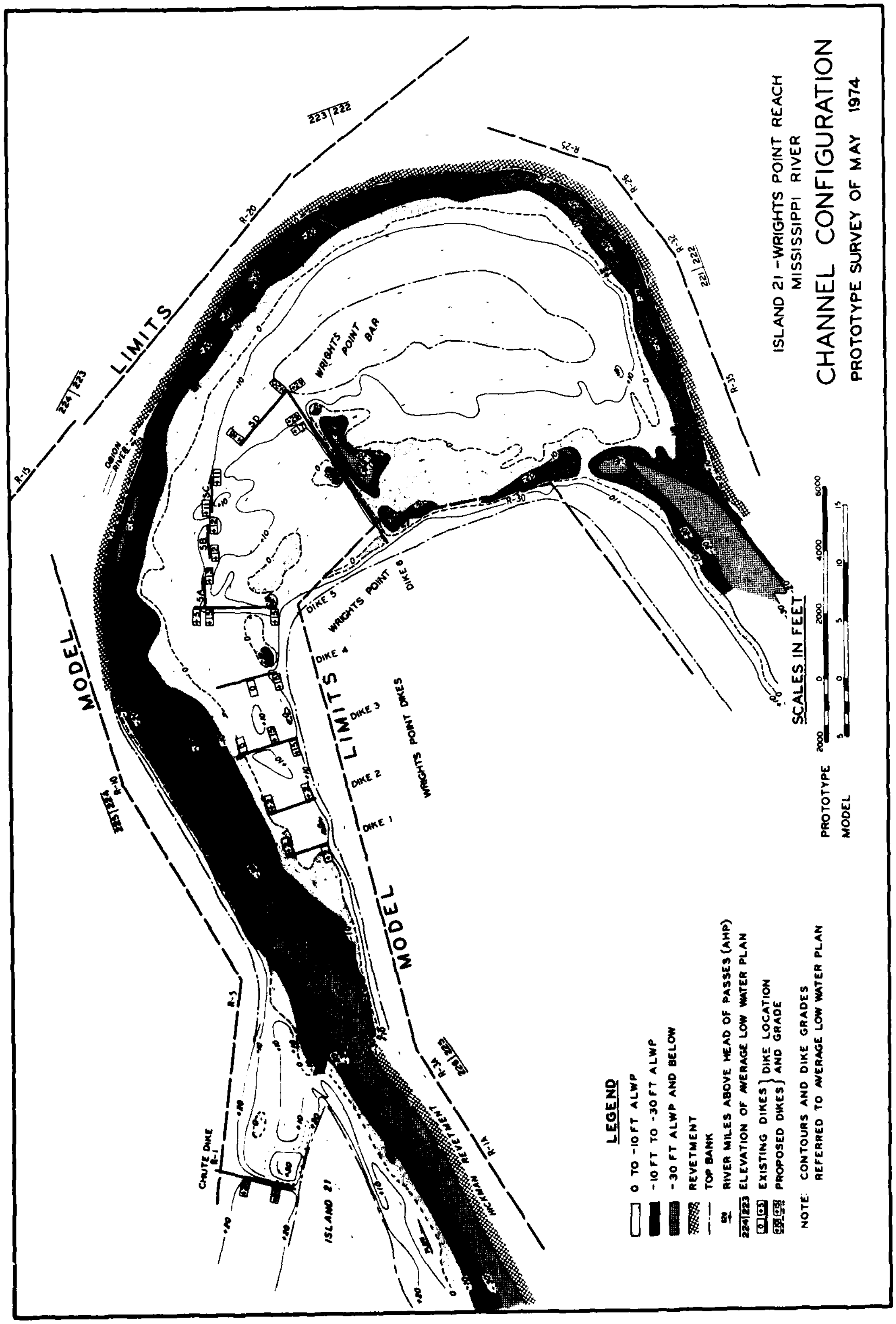
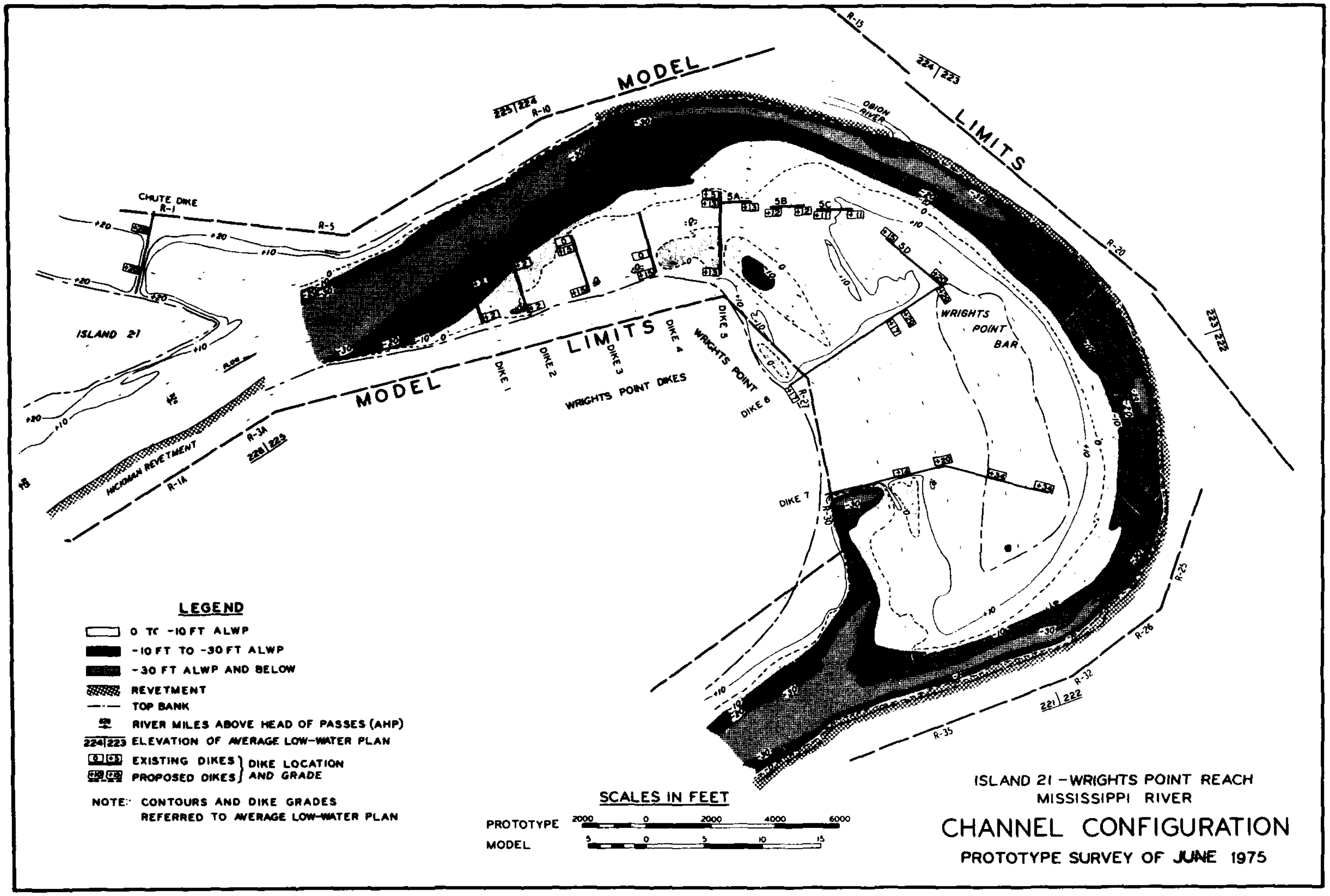

ISLAND 21 - WRIGHTS POINT REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE SURVEY OF MAY 1974
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
TOP BANK
RIVER MILES ABOVE HEAD OF PASSES (AHP)
ELEVATION OF AVERAGE LOW WATER PLAN
EXISTING DIKES } DIKE LOCATION
PROPOSED DIKES } AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW WATER PLAN
SCALES IN FEET
PROTOTYPE
MODEL
MODEL LIMITS
MODEL LIMITS
WRIGHTS POINT BAR
WRIGHTS POINT DIKES
WRIGHTS POINT
DIKE 1
DIKE 2
DIKE 3
DIKE 4
DIKE 5
DIKE 6
CHUTE DIKE
ISLAND 21
HICKMAN REVETMENT

PLATE 16


ISLAND 21 - WRIGHTS POINT REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE SURVEY OF JUNE 1975
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
TOP BANK
RIVER MILES ABOVE HEAD OF PASSES (AHP)
224|223 ELEVATION OF AVERAGE LOW-WATER PLAN
EXISTING DIKES
PROPOSED DIKES
DIKE LOCATION AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLAN
SCALES IN FEET
PROTOTYPE 2000 0 2000 4000 6000
MODEL 5 0 5 10 15
MODEL LIMITS
MODEL LIMITS
CHUTE DIKE
ISLAND 21
HICKMAN REVETMENT
OBION RIVER
WRIGHTS POINT BAR
WRIGHTS POINT DIKES
WRIGHTS POINT
DIKE 1
DIKE 2
DIKE 3
DIKE 4
DIKE 5
DIKE 6
DIKE 7
5A
5B
5C
5D
R-1
R-1A
R-3A
R-5
R-10
R-15
R-20
R-25
R-26
R-27
R-30
R-32
R-35
225|224
224|223
223|222
221|222
226|225

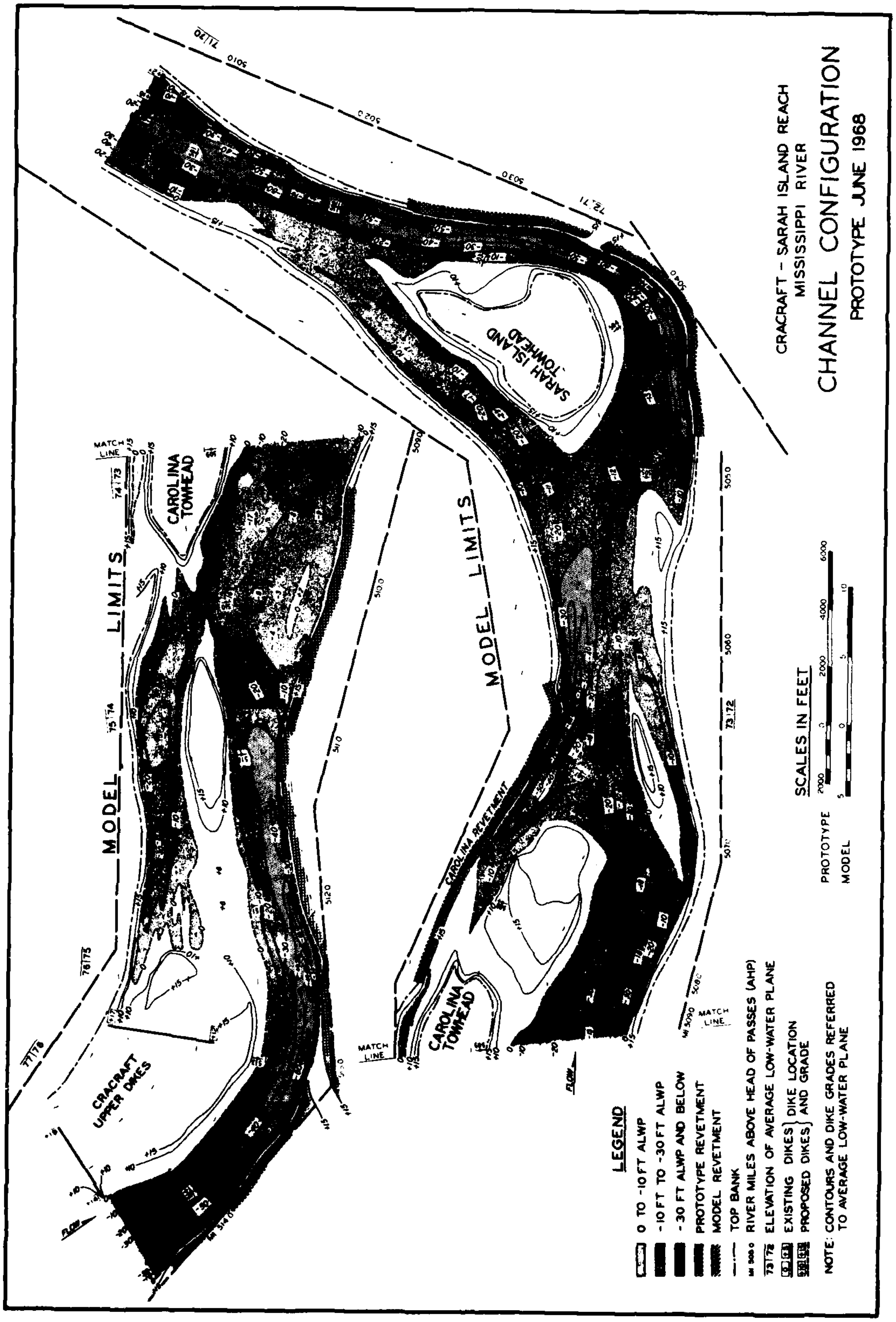
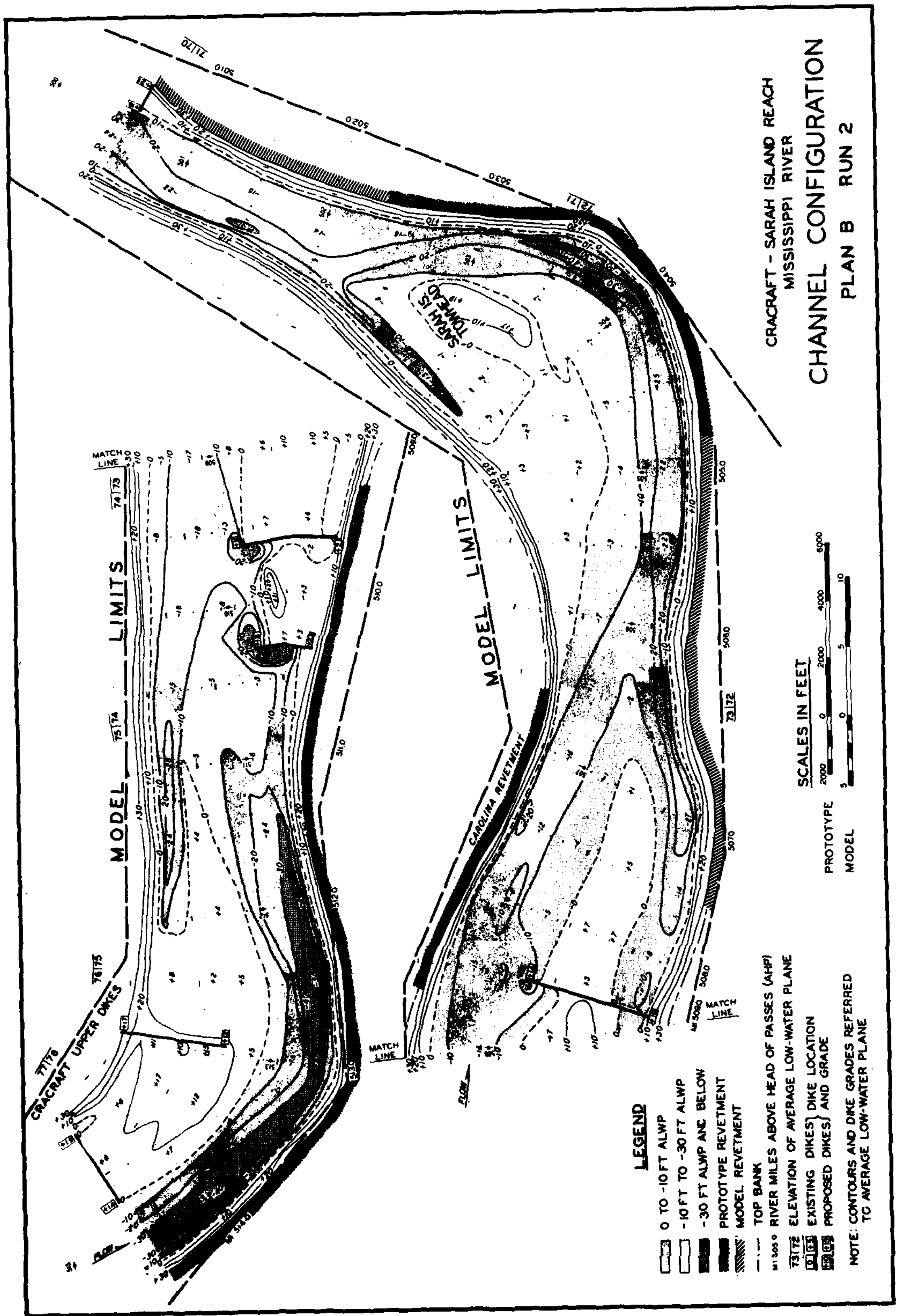
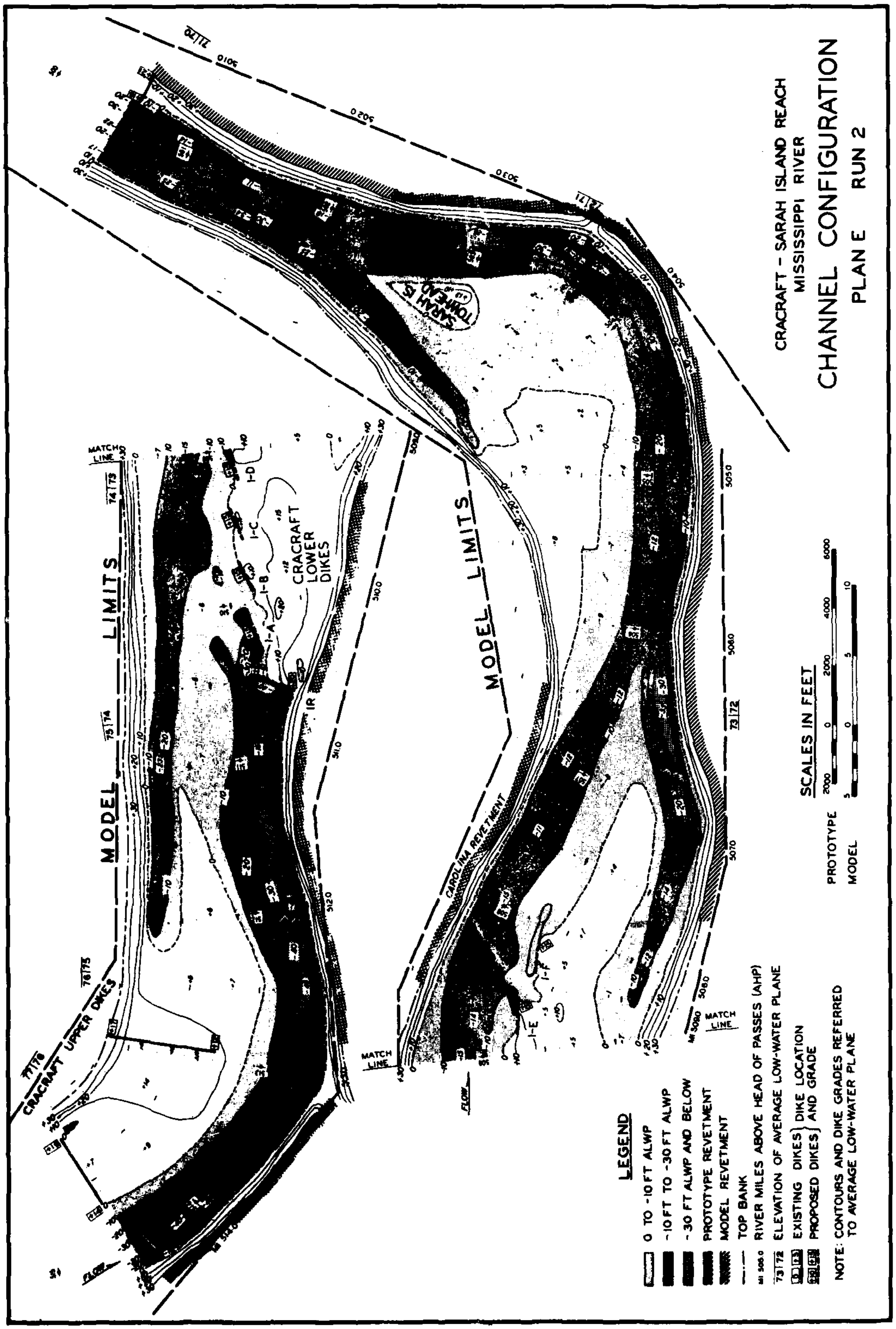

CRACRAFT - SARAH ISLAND REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE JUNE 1968
MODEL LIMITS
MODEL LIMITS
SARAH ISLAND TOWHEAD
CAROLINA TOWHEAD
CAROLINA TOWHEAD
CAROLINA REVETMENT
CRACRAFT UPPER DIKES
MATCH LINE
MATCH LINE
MATCH LINE
FLOW
FLOW
SCALES IN FEET
PROTOTYPE
MODEL
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
PROTOTYPE REVETMENT
MODEL REVETMENT
TOP BANK
RIVER MILES ABOVE HEAD OF PASSES (AHP)
ELEVATION OF AVERAGE LOW-WATER PLANE
EXISTING DIKES
PROPOSED DIKES
DIKE LOCATION AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE

PLATE 18


CRACRAFT - SARAH ISLAND REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PLAN B RUN 2
SCALES IN FEET
PROTOTYPE
MODEL
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
PROTOTYPE REVETMENT
MODEL REVETMENT
TOP BANK
RIVER MILES ABOVE HEAD OF PASSES (AHP)
ELEVATION OF AVERAGE LOW-WATER PLANE
EXISTING DIKES DIKE LOCATION
PROPOSED DIKES AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE
MODEL LIMITS
MODEL LIMITS
MATCH LINE
MATCH LINE
MATCH LINE
CRACRAFT UPPER DIKES
CAROLINA REVETMENT
SARAH IS. TOWHEAD
FLOW
FLOW



CRACRAFT - SARAH ISLAND REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PLAN E RUN 2
SCALES IN FEET
PROTOTYPE 2000 0 2000 4000 6000
MODEL 5 0 5 10
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
PROTOTYPE REVETMENT
MODEL REVETMENT
TOP BANK
MI 505.0 RIVER MILES ABOVE HEAD OF PASSES (AHP)
73|72 ELEVATION OF AVERAGE LOW-WATER PLANE
EXISTING DIKES
PROPOSED DIKES
DIKE LOCATION AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE
MODEL LIMITS
MODEL LIMITS
CRACRAFT LOWER DIKES
CRACRAFT UPPER DIKES
CAROLINA REVETMENT
SARAH IS. TOWHEAD
MATCH LINE
MATCH LINE
FLOW
FLOW

PLATE 20

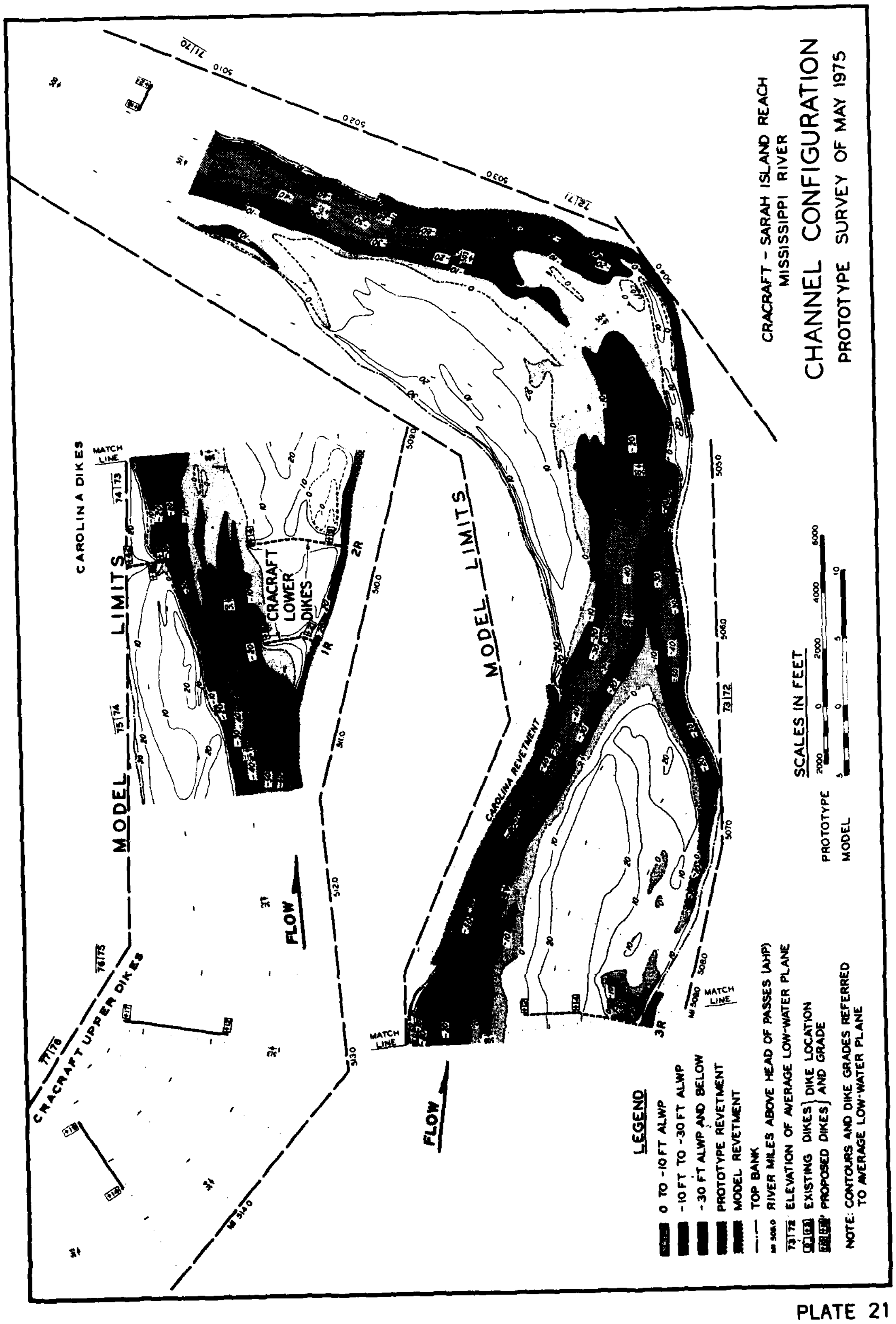

CRACRAFT - SARAH ISLAND REACH
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE SURVEY OF MAY 1975
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
PROTOTYPE REVETMENT
MODEL REVETMENT
TOP BANK
RIVER MILES ABOVE HEAD OF PASSES (AHP)
ELEVATION OF AVERAGE LOW-WATER PLANE
EXISTING DIKES
PROPOSED DIKES
DIKE LOCATION AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE
SCALES IN FEET
PROTOTYPE
MODEL
MODEL LIMITS
MODEL LIMITS
CAROLINA DIKES
CRACRAFT LOWER DIKES
CRACRAFT UPPER DIKES
CAROLINA REVETMENT
MATCH LINE
FLOW
FLOW
1R
2R
3R

PLATE 21

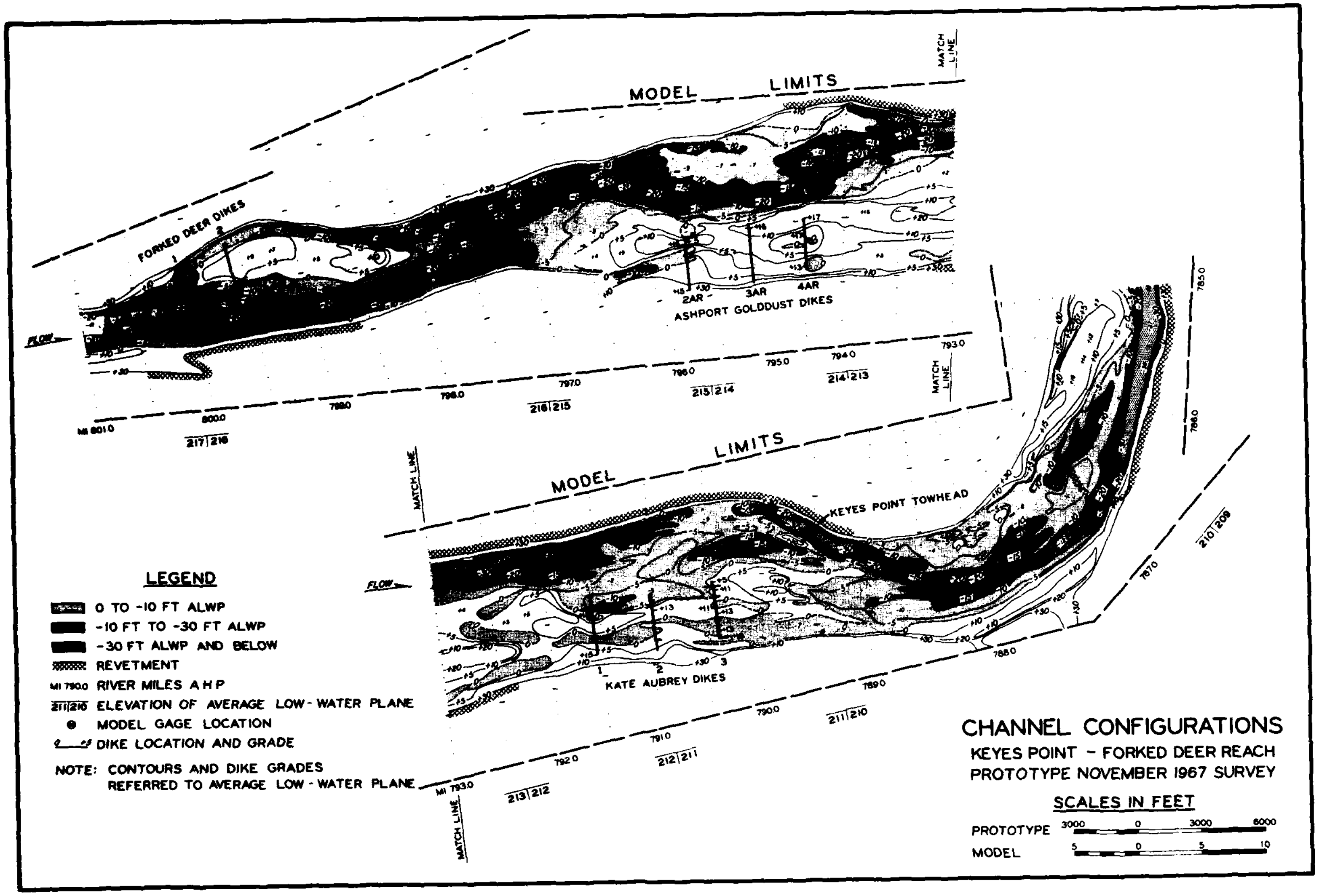
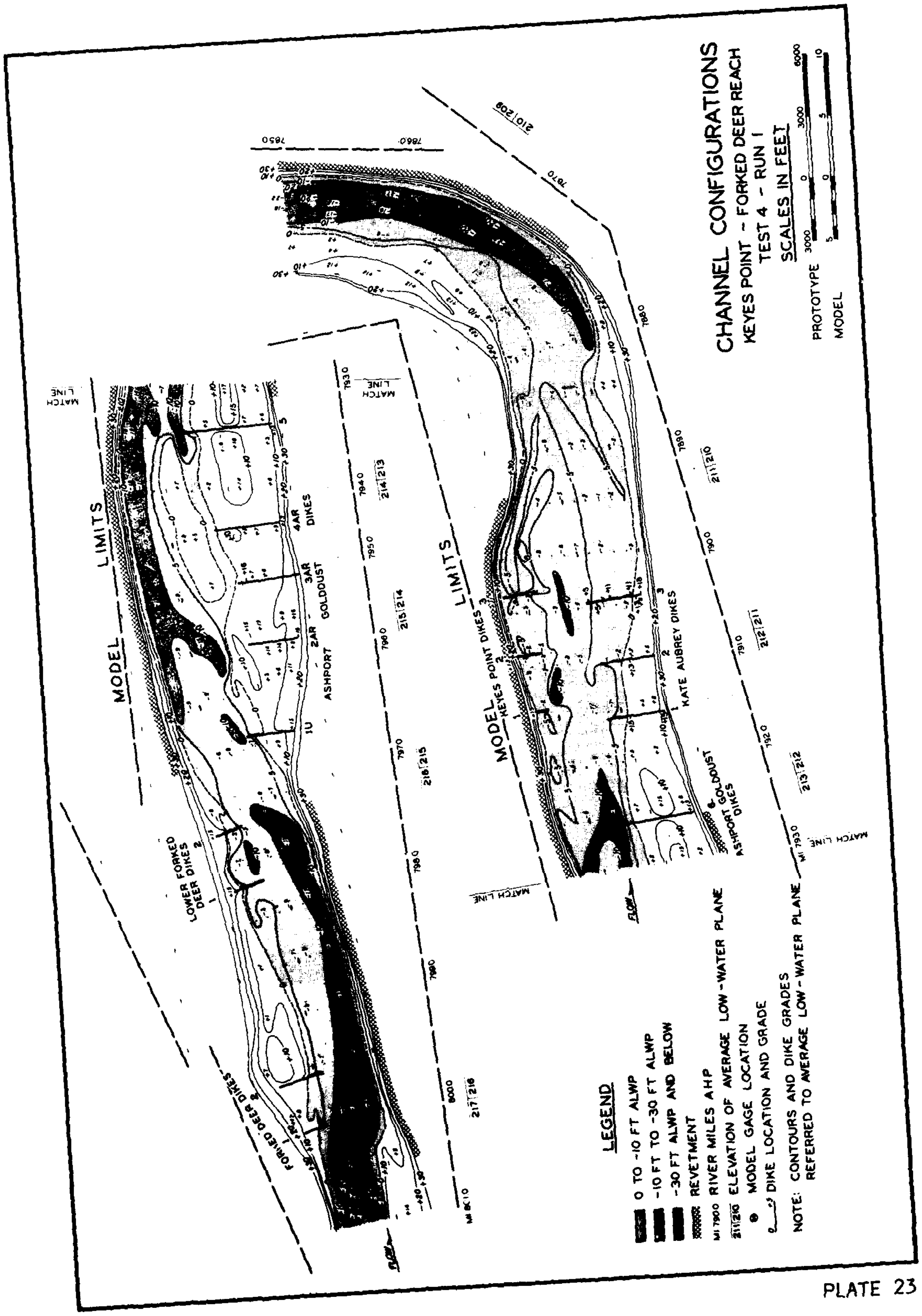
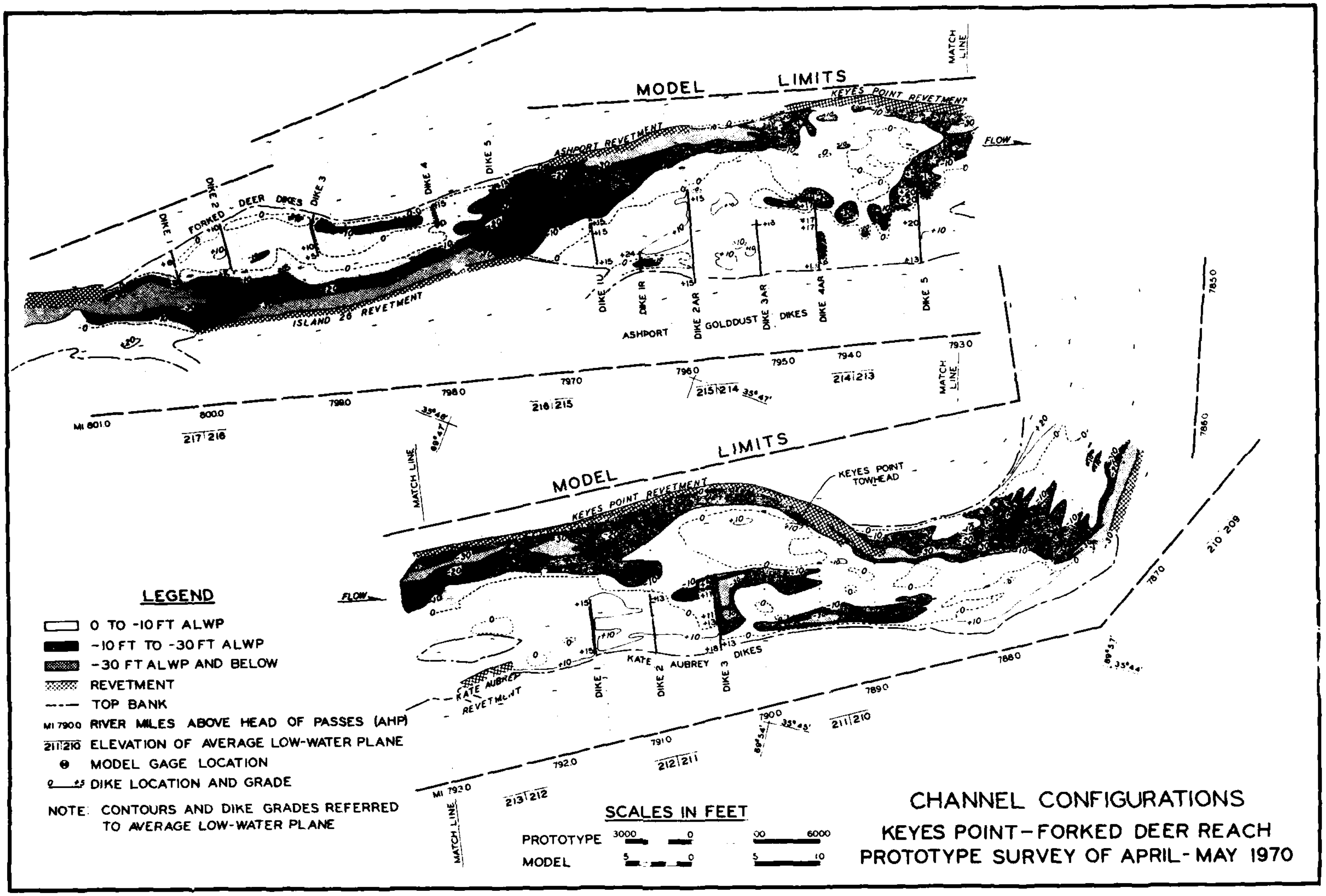

MODEL LIMITS
MATCH LINE
FORKED DEER DIKES
FLOW
ASHPORT GOLDDUST DIKES
2AR
3AR
4AR
MI 801.0
800.0
799.0
798.0
797.0
796.0
795.0
794.0
793.0
217|216
216|215
215|214
214|213
MODEL LIMITS
KEYES POINT TOWHEAD
KATE AUBREY DIKES
MI 793.0
792.0
791.0
790.0
789.0
788.0
787.0
786.0
785.0
213|212
212|211
211|210
210|209
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
MI 790.0 RIVER MILES AHP
211|210 ELEVATION OF AVERAGE LOW-WATER PLANE
MODEL GAGE LOCATION
DIKE LOCATION AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE
CHANNEL CONFIGURATIONS
KEYES POINT - FORKED DEER REACH
PROTOTYPE NOVEMBER 1967 SURVEY
SCALES IN FEET
PROTOTYPE 3000 0 3000 6000
MODEL 5 0 5 10

PLATE 22



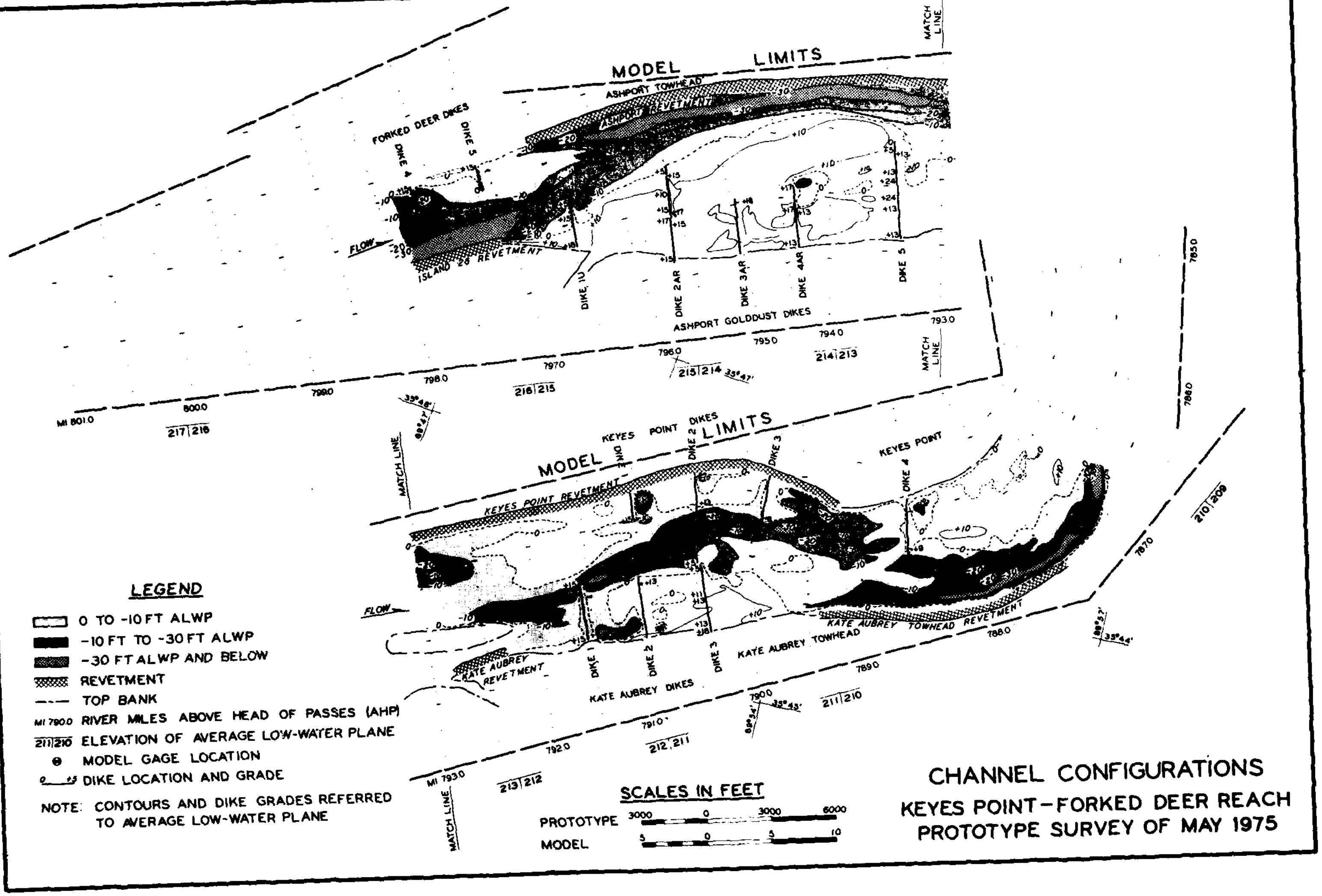
CHANNEL CONFIGURATIONS
KEYES POINT - FORKED DEER REACH
TEST 4 - RUN 1
SCALES IN FEET
PROTOTYPE
MODEL
MODEL LIMITS
MODEL LIMITS
MATCH LINE
MATCH LINE
MATCH LINE
MATCH LINE
LOWER FORKED DEER DIKES
FORKED DEER DIKES
ASHPORT GOLDOUST DIKES
KEYES POINT DIKES
KATE AUBREY DIKES
ASHPORT GOLDOUST DIKES
FLOW
FLOW
LEGEND
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT ALWP AND BELOW
REVETMENT
RIVER MILES AHP
ELEVATION OF AVERAGE LOW-WATER PLANE
MODEL GAGE LOCATION
DIKE LOCATION AND GRADE
NOTE: CONTOURS AND DIKE GRADES REFERRED TO AVERAGE LOW-WATER PLANE

PLATE 23



CHANNEL CONFIGURATIONS
KEYES POINT-FORKED DEER REACH
PROTOTYPE SURVEY OF APRIL-MAY 1970

PLATE 24



CHANNEL CONFIGURATIONS
KEYES POINT-FORKED DEER REACH
PROTOTYPE SURVEY OF MAY 1975

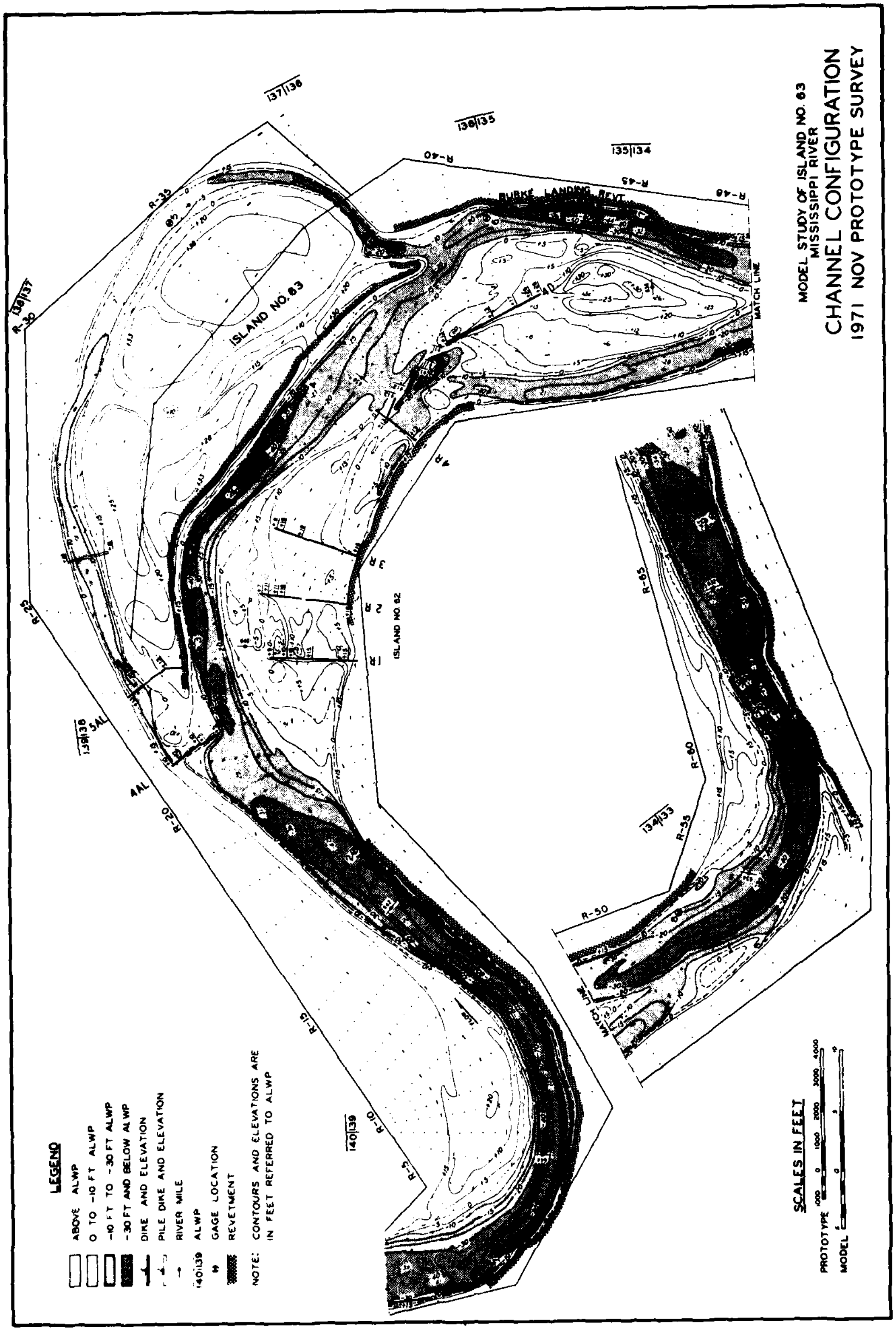

MODEL STUDY OF ISLAND NO. 63
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
1971 NOV PROTOTYPE SURVEY
LEGEND
ABOVE ALWP
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT AND BELOW ALWP
DIKE AND ELEVATION
PILE DIKE AND ELEVATION
RIVER MILE
140|139 ALWP
GAGE LOCATION
REVETMENT
NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO ALWP
SCALES IN FEET
PROTOTYPE
MODEL
ISLAND NO. 63
ISLAND NO 62
BURKE LANDING REVT
MATCH LINE
137|136
136|135
135|134
138|137
139|138
140|139
134|133
R-5
R-10
R-15
R-20
R-25
R-30
R-35
R-40
R-45
R-48
R-50
R-55
R-60
R-65

PLATE 26

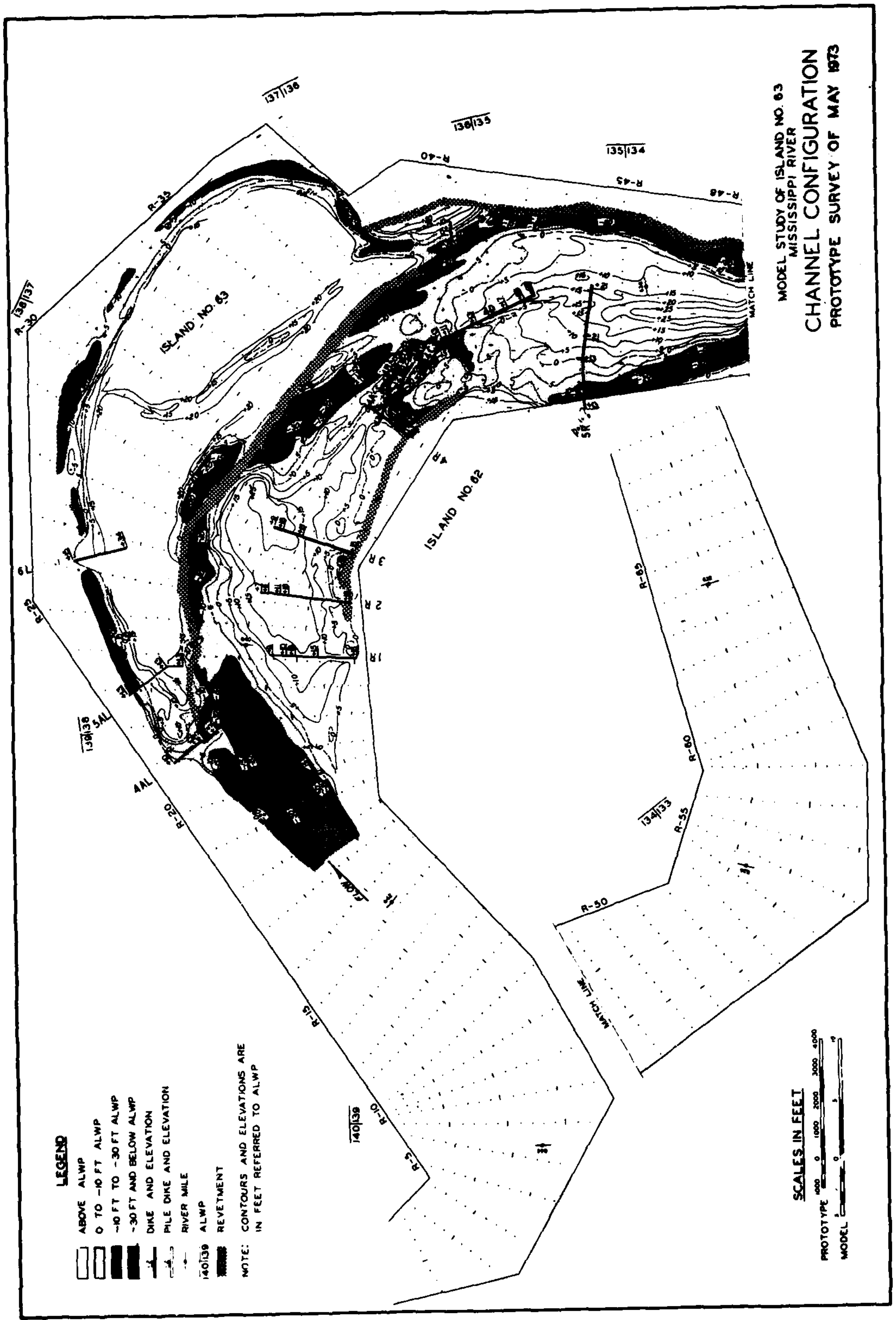

MODEL STUDY OF ISLAND NO. 63
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE SURVEY OF MAY 1973
ISLAND NO. 63
ISLAND NO. 62
LEGEND
ABOVE ALWP
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT AND BELOW ALWP
DIKE AND ELEVATION
PILE DIKE AND ELEVATION
RIVER MILE
ALWP
REVETMENT
NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO ALWP
SCALES IN FEET
PROTOTYPE
MODEL
MATCH LINE
FLOW

PLATE 27

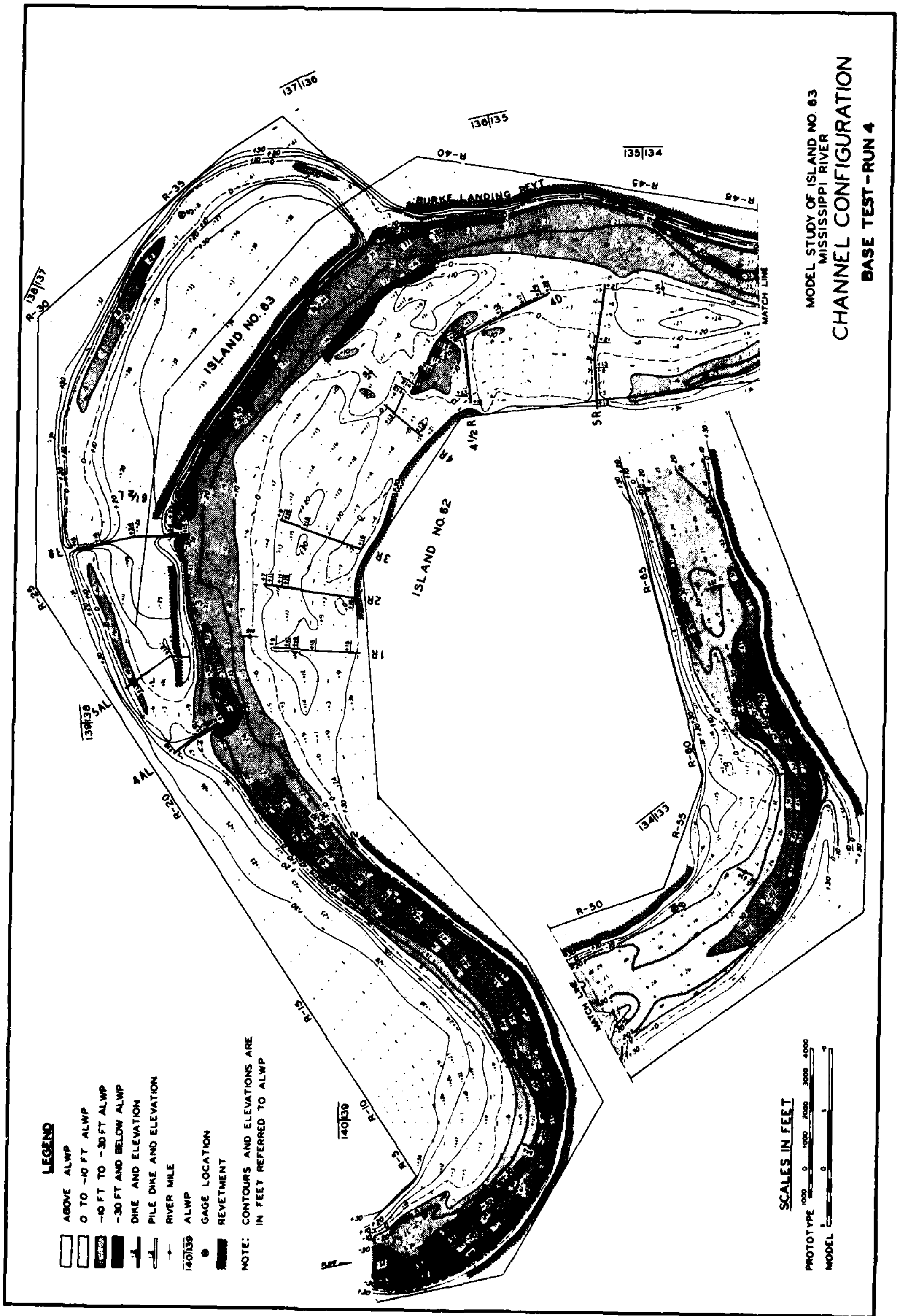

MODEL STUDY OF ISLAND NO 63
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
BASE TEST-RUN 4
LEGEND
ABOVE ALWP
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT AND BELOW ALWP
DIKE AND ELEVATION
PILE DIKE AND ELEVATION
RIVER MILE
ALWP
GAGE LOCATION
REVETMENT
NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO ALWP
SCALES IN FEET
PROTOTYPE
MODEL
ISLAND NO. 63
ISLAND NO. 62
BURKE LANDING REVT
MATCH LINE

PLATE 28

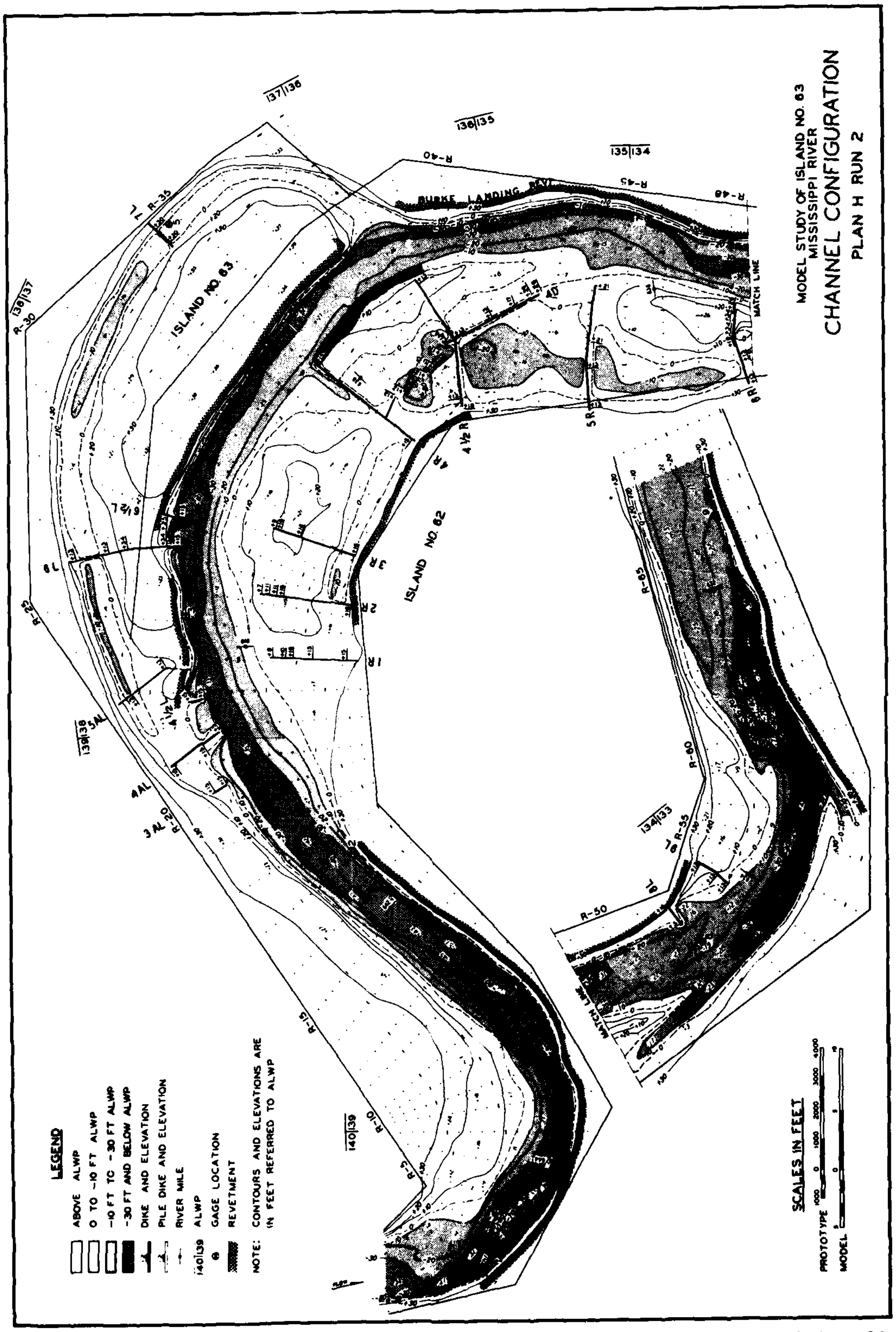

MODEL STUDY OF ISLAND NO. 63
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PLAN H RUN 2
LEGEND
ABOVE ALWP
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT AND BELOW ALWP
DIKE AND ELEVATION
PILE DIKE AND ELEVATION
RIVER MILE
ALWP
GAGE LOCATION
REVETMENT
NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO ALWP
SCALES IN FEET
PROTOTYPE
MODEL
ISLAND NO. 63
ISLAND NO. 62
BURKE LANDING REVT
MATCH LINE
R-30
R-35
R-40
R-45
R-48
R-25
R-20
R-15
R-10
R-50
R-55
R-60
R-65
137|136
136|135
135|134
138|137
139|138
140|139
134|133

PLATE 29

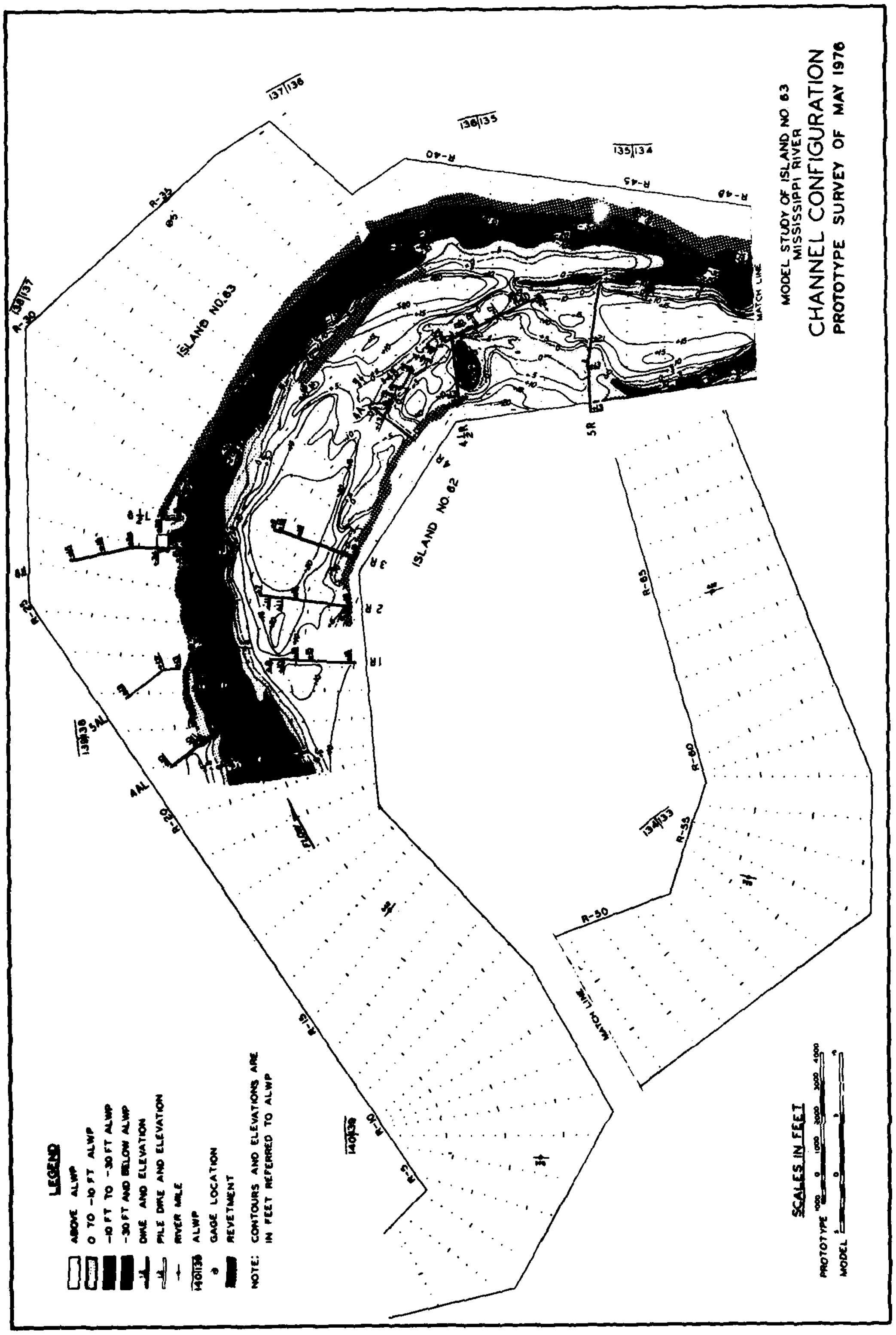

MODEL STUDY OF ISLAND NO 63
MISSISSIPPI RIVER
CHANNEL CONFIGURATION
PROTOTYPE SURVEY OF MAY 1976
ISLAND NO. 63
ISLAND NO. 62
MATCH LINE
LEGEND
ABOVE ALWP
0 TO -10 FT ALWP
-10 FT TO -30 FT ALWP
-30 FT AND BELOW ALWP
DIKE AND ELEVATION
PILE DIKE AND ELEVATION
RIVER MILE
ALWP
GAGE LOCATION
REVETMENT
NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO ALWP
SCALES IN FEET
PROTOTYPE
MODEL

PLATE 30

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Franco, John J.

Summary report: Model-prototype comparison study of dike systems, Mississippi River : Potamology investigations / by John J. Franco (Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. : available from NTIS, 1982.

55 p., 30 p. of plates ; ill. ; 27 cm. -- (Technical report ; HL-82-11)

Cover title.

"May 1982."

Final report.

"Prepared for The President, Mississippi River Commission."

1. Dikes (Engineering). 2. Hydraulic models. 3. Mississippi River. 4. Rivers--Regulation. I. United States. Mississippi River Commission. II. U.S. Army Engineer Waterways Experiment Station. Hydraulics Laboratory. III. Title IV. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; HL-82-11.

TA7.W34 no.HL-82-11

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